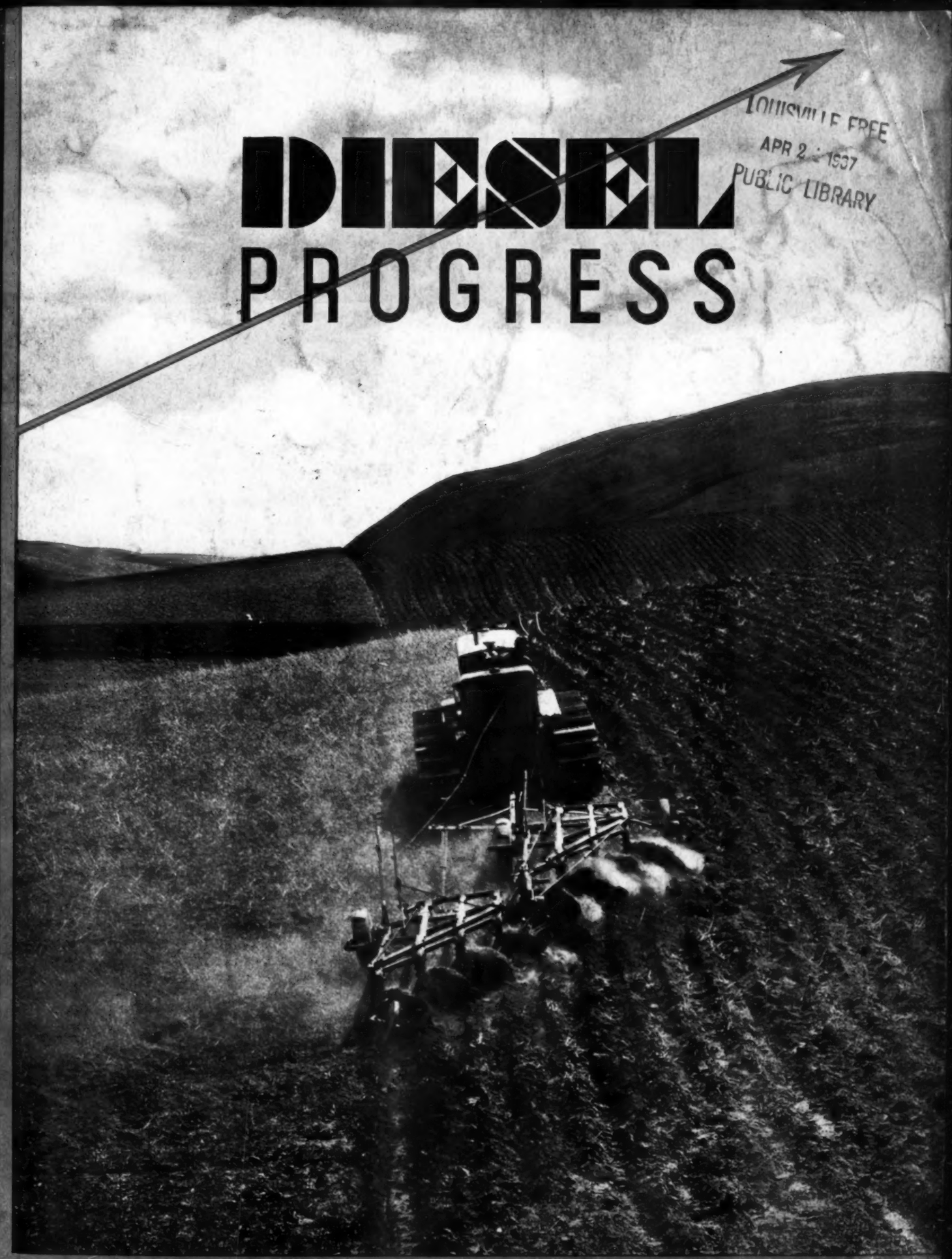
DIESEL PROGRESS

IN INDUSTRY • IN TRANSPORTATION • ON THE SEA • IN THE AIR

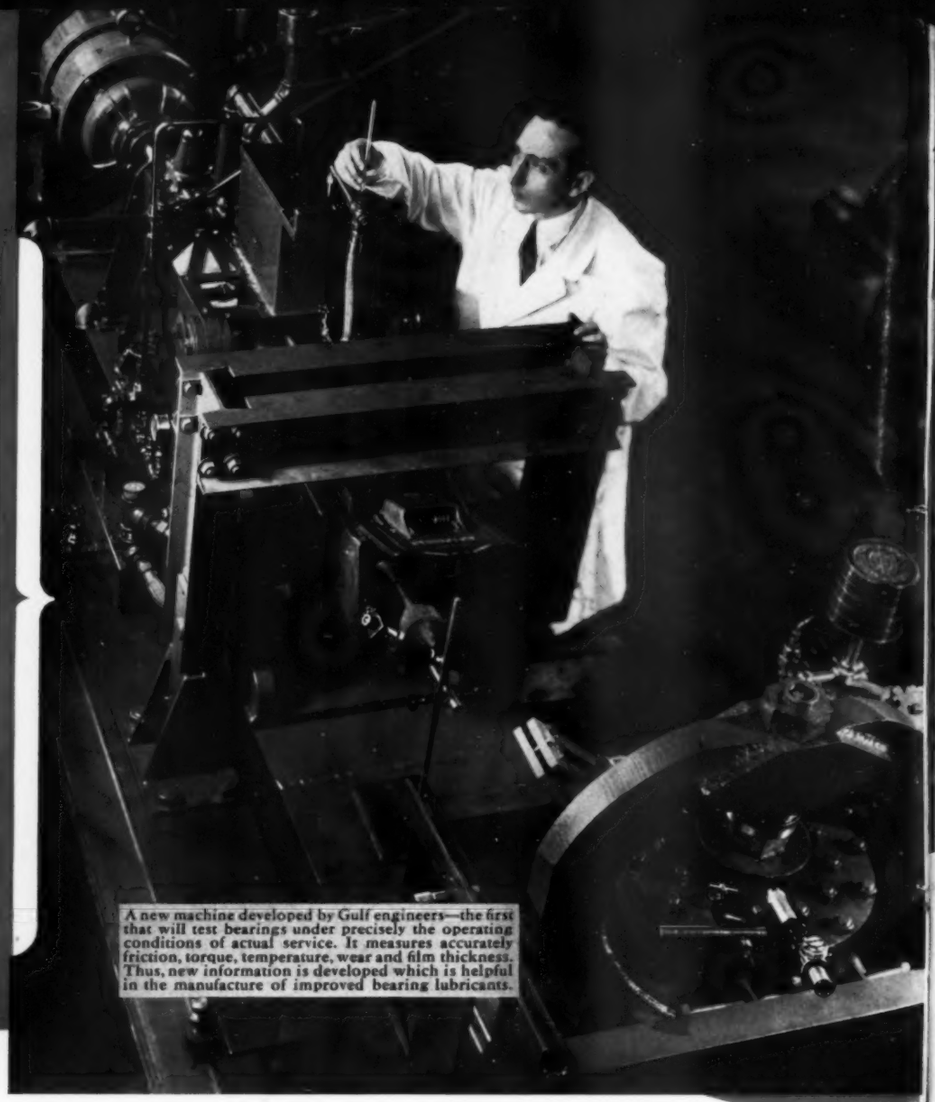
LOUISVILLE FREE
APR 2 - 1937
PUBLIC LIBRARY



APRIL, 1937 CIRCULATION OF THIS ISSUE—IN EXCESS OF 11,000 COPIES 25c

Proving

THE FACTS ABOUT BEARINGS AND THEIR LUBRICATION



A new machine developed by Gulf engineers—the first that will test bearings under precisely the operating conditions of actual service. It measures accurately friction, torque, temperature, wear and film thickness. Thus, new information is developed which is helpful in the manufacture of improved bearing lubricants.

GULF ENGINEERS Seek . . . and FIND . . . the Answers

to many questions regarding bearing lubrication

WHAT is the practical relation of viscosity to shaft speed, bearing load and various bearing metals?

WHY are some bearings *easy* to lubricate while others of similar construction and in similar service are *difficult* to lubricate?

HOW can present day lubricants be further improved to anticipate future progress in bearing design and application?

THESE and many other problems regarding bearing performance are being studied every day by Gulf scientists in the most modern petroleum research laboratory in the world.

These laboratory findings—supplemented by 37 years of practical experience—are being converted into operating benefits for industry. The result—to users of Gulf quality lubricants—is lower costs for maintenance and lubrication.

GULF INDUSTRIAL LUBRICATION

Makers of GULF NO-NOX ETHYL GASOLINE AND GULFPRIDE OIL

GULF OIL CORPORATION
GULF REFINING COMPANY

GENERAL OFFICES: GULF BUILDING, PITTSBURGH, PA.

DIESEL PROGRESS for April, 1937. Volume III, No. 4. DIESEL PROGRESS is published monthly by Diesel Engines, Inc., 2 West Forty-fifth Street, New York, N. Y. Rex W. Wadman, President. Acceptance under the Act of June 5, 1934, at Brooklyn, New York, authorized May 14, 1935. Subscription rates: United States and Pan American countries $3.00, Canada and all other countries $5.00 per year. Single copy price 25 cents in U.S.A., 50 cents for all other countries.

PERFORMANCE *Counts*

PONCA CITY GETS ITS FIFTH ENGINE

★ In 1923, Ponca City, Oklahoma, purchased its first Nordberg Diesel engine, a 1250 horsepower, two cycle, air injection unit. Two years later, a second engine was installed and then two more in 1927, all duplicates of the original installation.

Because of these many years of reliable and economical service, Ponca City again turned to Nordberg Diesels when additional capacity was required. To the present 5000 horsepower municipal plant capacity is to be added a fifth and larger Nordberg unit, this being a 2250 horsepower, six cylinder, air injection, two cycle engine. With 7250 total installed horsepower, this plant will rank among the larger Diesel-engined municipal power plants in this country.

The new unit will operate on 8° to 12° Baume' oil, the same fuel that the older engines have been operating on for many years. This is just one more instance where Nordberg Diesels have given years of profitable operation on heavy low grade fuel and with very low maintenance cost.

When considering a new power plant or additional capacity, or where low grade fuel oil is available, Nordberg can recommend an engine best suited for the service required.

★ Nordberg Diesel engines are available for every power requirement in two and four cycle types, and in a wide range of sizes.

NORDBERG MFG. CO., Milwaukee, Wis.

NEW YORK	WASHINGTON	CLEVELAND	KANSAS CITY	DALLAS	LOS ANGELES
60 E. 42nd St.	Barr Bldg.	Rockefeller Bldg.	3560 Broadway	3801 Potomac Ave.	Subway Term. Bldg.

OWNERS OF GASOLINE AND DIESEL EQUIPMENT APPROVE STRINGENT TESTS FOR MOTOR OILS

Is it good oil? How thoroughly will it lubricate? These, and many others like them, are questions that have plagued motor owners constantly. The only way they could judge a motor oil was to try it in their motors for a considerable period of time. This "pig-in-a-poke" problem has now been solved. Motor owners can now make several simple tests that show accurately how any oil will act in actual operation. It is no longer necessary to endanger expensive motors by using them as test "guinea pigs" for motor oil.

A group of petroleum and mechanical engineers of the Macmillan Petroleum Corporation developed the tests of motor oil by first listing the qualities a fine motor oil *must* have. Then, these engineers developed simplified mechanical ways of testing the qualities listed. The *must* qualities selected by the engineers were:

A fine motor oil must maintain an unbroken film on metal under extreme pressures.

A fine motor oil film must also remain unbroken under conditions of unusual heat.

A fine motor oil must cling to metal surfaces for long periods of time.

A fine motor oil must be able to penetrate and creep to seemingly inaccessible surfaces to prevent friction.

A fine motor oil must not leave harmful, hard carbon.

A fine motor oil must not corrode metal surfaces.

In other words, a fine motor oil must quickly form a film between all moving metal parts of a motor, and then, stay there under extreme conditions.

1. FILM STRENGTH

To test and prove the pressure-resisting film strength of oil, the engineers use the film-strength testing machine pictured here.

This machine consists of a small electric motor which rotates a twin belt driven jack-shaft at 500 revolutions per minute. A Timken tapered roller from a stock Timken bearing is locked in a lever system that applies direct pressure of the roller on a Timken roller bearing cup that is locked on the end of the rotating jack-shaft. The lever system multiplies the pressure of the weights added at the end of the lever arm so that *each one pound weight increases the pressure at the ratio of 800 pounds to the square inch.* Weights are added each half minute until the oil film breaks. This test is too severe on many compounded or blended oils. Some withstand from 1 to 7 weights but Macmillan Ring-free withstands 20 and more weights, or upwards of 16,000 pounds pressure.

2. RESISTANCE TO HEAT

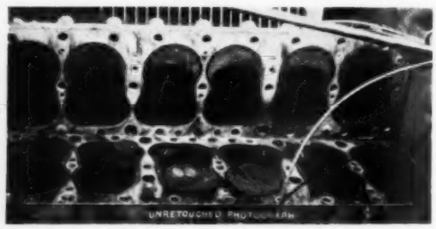
To test and prove the heat resisting quality of motor oils the same machine is used, and in this case, the oil is heated and tested while hot.

Many oils suffer great loss of film strength under conditions of unusual heat which too often allows metal seizure and mechanical break-down in actual operation. The best motor oil is the oil that retains its *full film-strength even at high oil temperatures.*

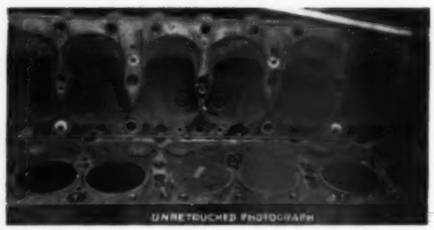
Points of friction in a motor vary in temperature depending on many conditions such as location close to point of combustion, fit of the motor parts, flow of oil and the condition of the cooling system. It is good maintenance policy to be sure a motor oil has sufficient margin of extra resistance to heat to withstand abnormal conditions.

3. CLING

To test and prove the tendency of an oil to cling to metal surfaces, a modified set of laboratory balances are used. Identical steel paddles machined to a sharp drip point are cleaned and set in balance on the scales. Then, the paddles are dipped, one in each oil to be tested, and again hung on the scales. Surplus oil gradually drains off and the weights of the oil left on the paddles shows which oil clings the longest. With this equipment the oils can be tested either hot or cold.



Studebaker Motor at 47,509 miles.



Same Motor after 2956 miles with RING-FREE

The quality of cling is of vital importance in a motor oil. When motors are stopped, the hot oil has a natural tendency to drain off the hot vertical surfaces of the internal parts. To prevent excessive wear when the motor is again started an oil film must be present on all surfaces. The oil that clings the best, leaves the best film, thus reduces the wear on cold starts more than other oils.

4. PENETRATION

To test and prove the degree of penetration of an oil, these engineers selected the problem of loosening nuts and bolts on old rusty mufflers. Every mechanic knows that these bolts are generally so rusted and baked into place that it is practically impossible to loosen them. Try one oil on a couple of them and the other oil on a couple more. The oil that loosens the nuts and bolts quickest, proves it penetrates best.

This quality of penetration is more important in modern motors with their miscroscopic tolerances than in old style, loosely fitted motors. In addition, points of the motor not served by pressure oil systems such as valve stems and guides, top piston rings and upper cylinder walls too often suffer from lack of oil. The best oil will reach these points by its quality of superior penetration.

Faster penetration occasionally shows up when oil pans are slightly loose and crankshaft packings are worn. Then, penetration causes a loss of oil which is often mistaken for over-consumption.

5. REMOVE CARBON

To test and prove quickly the ability of a motor oil to prevent and remove hard carbon deposits is quite possible. The best test is, of course, actual use.

A quick convincing test of carbon formation and carbon removal can be made with a standard type heater with rheostat control and several evaporating dishes. Place a dish on the heater and heat it to the proper degree. Drop two drops of any popular brand oil on the hot dish. Watch it evaporate and see the carbon it leaves behind. Make the same test with Macmillan Ring-free Motor Oil in another dish and see that no carbon is left. Then, reheat the first dish with its dirty carbon blotch and, when hot, place a drop of Macmillan Ring-free on the carbon spot. It will evaporate taking the carbon with it.

This quality of carbon removal naturally turns oil black in dirty motors and the oil is judged dirty and worn-out by mechanics who are not acquainted with this feature. To prove such darkened oil

is still good, simply test its film-strength on the machine.

Carbon is without question the No. 1 curse of motor operation. The motor oil that washes carbon troubles away will not only save great sums of money for gasoline motor operators but will be even more God-send for the owners of diesel equipment in releasing stuck piston rings and keeping the rings free. The best carbon removing motor oil will more than double the time between overhauls, and often rescue a clogged motor from an immediate overhaul.

6. NON-CORROSIVE

The sixth quality of freedom from corrosiveness is of growing importance because of the new-type alloys used in crankshaft and connecting rod bearings and because of hood and radiator design trends that injure the efficiency of the cooling systems. To test and prove whether or not an oil is corrosive use the Federal Government test for corrosiveness printed in its publication, "Federal Specifications for Lubricants and Liquid Fuels," No. VVL791, published October 3, 1933. In this pamphlet under the index number F 511 is this instruction:

"Place a clean strip of mechanically polished pure sheet copper about ½ inch wide and 3 inches long in a clean test tube. Add enough of the sample oil to be tested to cover the strip completely. Close the tube with a vented stopper and maintain for 3 hours at 212 degrees Fahrenheit. Rinse the copper strip with sulfur-free acetone and compare it with a similar strip of freshly polished copper. Discoloration or pitting indicates corrosion." This is what happens when corrosive oils are used in motors with copper-lead, cadmium silver or other of the new motor bearing alloys.

This simple test proves conclusively whether or not a motor oil contains corrosive material. Many oils will gradually become corrosive in use. The products of combustion help to form corrosive materials that wash down into the crankcase.

The combination of these seven tests definitely prove the lubricating qualities of a motor oil. Yet, some mechanics not well versed in lubrication will not consider such tests as conclusive evidence. On the other hand who can deny that when any group of motor oils is subjected to these same identical tests, it is not difficult to determine the merit or strength of one, and the weaknesses of the others. They will argue that the best test is actual use. So, engineers who developed these tests went further and devised a simple performance test to prove the friction-reducing quality of an oil.

The test is based on first realizing the amount of friction present in the average motor and then watching for evidence that that friction has been reduced. One of America's leading automotive engineers made this significant statement in the October, 1933, issue of the S. A. E. Journal: "With regard to engine friction at 40 miles per hour, 50 per cent of the horsepower developed by the engine is used in overcoming this loss."

In other words, at a speed of 40 miles per hour on the level road half the gasoline used is eaten up overcoming friction inside the motor. And, remember, that is the condition when the average high-quality oils are used. With poor oil the friction loss is greater.

Friction in the motor not only causes power loss but is the cause of practically all wear on motor parts. If that friction is reduced; then power is increased and wear is reduced.

The best motor oil will reduce friction more than ordinary oils, thus releasing more horsepower to the driveshaft which, in turn, will cause the car to perform better. Simply see how many feet distance is required to accelerate from 10 to 60 m. p. h.; first with one oil, then with another. Or, see how fast your car will go over a hill, starting at the bottom at ten miles per hour. Use one oil; then the other. Or, using a "Gas-per-mile" gauge, see how far your car will run on a 1/10 gallon of gasoline with one oil and then the other, on a level highway.

STANDS THE GAFF

These are all performance tests that prove comparatively the amount of horsepower delivered by the motor. Improved performance is also eloquent proof that friction-wear has been reduced in the motor. Less wear means less repair and longer motor life.

Any oil that sets a high record in all these tests, proves it has the strength to stand-up under the most strenuous operation. Macmillan Ring-free Motor Oil is "custom-tailored" by a patented refining process that gives it these *must* qualities. Macmillan engineers spent seven years developing this refining process. They demanded that the process eliminate the practice of blending, the use of excessive heat and that it produce a pure petroleum product that is not doped or doctored in any way—an oil that would be sludge-free.

You can quickly prove for yourself whether or not they succeeded by testing Macmillan Ring-free Motor Oil in comparison with any other motor oil available today—by any of these practical exacting tests, or by a genuine performance test in your power equipment.

A TRIBUTE TO THE *Finest* MOTOR OIL

● In thousands of gasoline and diesel motors throughout the land Macmillan Ring-free Motor Oil is running up new records of lubrication. Hundreds of users have written testimonials of their experiences with this oil. These are the RING-FREE honor roll and today they include the following makes of motors:

HONOR ROLL

DIESEL MOTORS

ALLIS-CHALMERS
ANDERSON
ATLAS
AUSTIN-WESTERN
AUTOCAR
BUCKEYE
BUCYRUS-ERIE
BUDA
BUSCH SULZER
CATERPILLAR
CHICAGO PNEUMATIC
CLARK
CLETRAC
CLIMAX
CUMMINS
DIAMOND T
FAIRBANKS-MORSE
FULTON
HERCULES
HUG TRUCK
INTERNATIONAL
GALENBERG
LATHROP
MACK TRUCKS
McCORMICK-DEERING
MUNCIE
NATIONAL SUPERIOR
NORBERG
ST. MARYS
STERLING
TWIN COACH
VENN-SEVERIN
WAUKESHA
WAUKESHA-LIMA SHOVEL
WAUKESHA-HESSELMAN
WITTE
WOLVERINE

GASOLINE AND DRY GAS MOTORS

ALLIS-CHALMERS
AUTOCAR TRUCK
CASE TRACTOR
CATERPILLAR
CHEVROLET
CLETRAC
CONTINENTAL
DANDEE MIXER
DEXTER FOLDER
JOHN DEERE
DIAMOND T
ELCO
FAGEOL TRUCKS
FARMALL TRACTORS
FEDERAL TRUCKS
FORDSON
FOSTER COVERS
FRANKLIN PUMPS
G.M.C. TRUCKS
HALLSCOTT
HICKOK RULERS
HOLT
INDIAN MOTORCYCLES
INDIANA TRUCKS
INGERSOLL-RAND COMPRESSORS
INTERNATIONAL
JOHNSON PUMPS
LE ROI GAS ENGINES
LOGEMAN COMPRESSORS
LORAIN SHOVELS
MACK TRUCKS
MASSEY-HARRIS
REO TRUCKS
REX MIXERS
ROSEBACK PERFORATOR
SEYBOLD CUTTER
STERLING
STEWART TRUCKS
TWIN COACH
UNITED MOTORS
VILTER COMPRESSOR
WHITE TRUCKS
YORK COMPRESSOR

● MACMILLAN PETROLEUM CORPORATION ●
530 W. Sixth St., Los Angeles, or El Dorado, Ark.

MACMILLAN
RING-FREE
MOTOR OIL

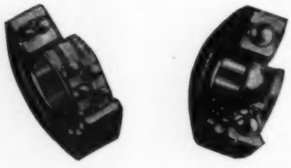
1. GREATER FILM STRENGTH
2. HIGHER HEAT RESISTANCE
3. LONGER CLING TO METAL
4. FASTER PENETRATION
5. REMOVES HARD CARBON
6. IS NOT CORROSIVE

SKF BEARINGS *Modernize* DIESELS

ON CRANKSHAFTS

ON PISTON PINS

ON CAMSHAFTS

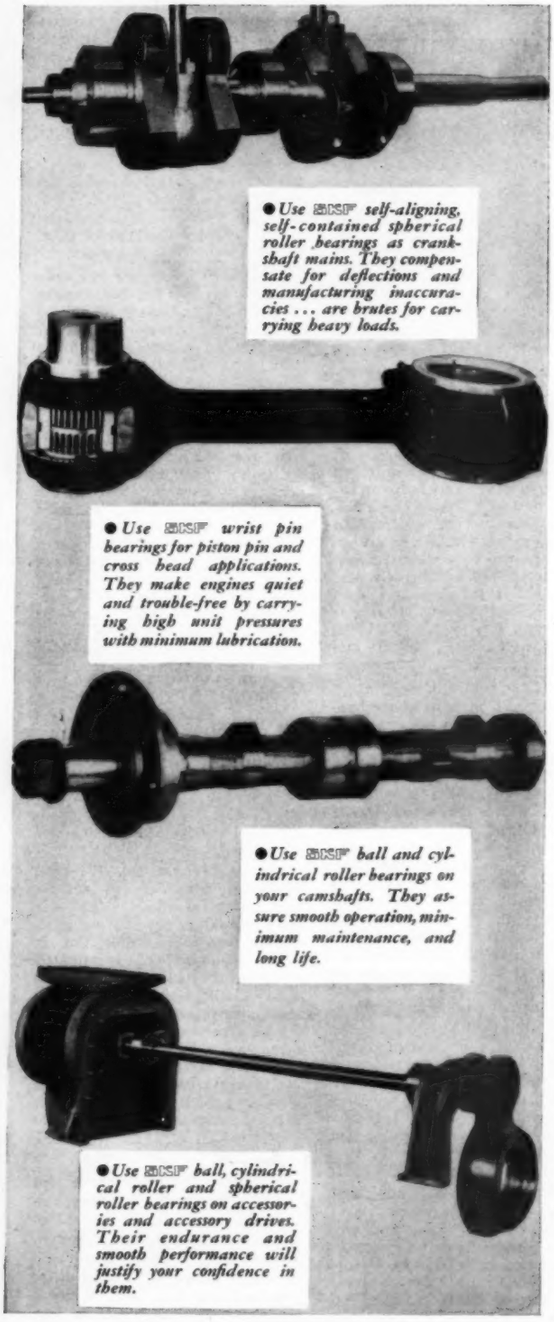


ON ACCESSORIES

SKF INDUSTRIES, INC., FRONT ST., & ERIE AVE., PHILA., PA.

3835

SKF
BEARINGS



● *Use SKF self-aligning, self-contained spherical roller bearings as crankshaft mains. They compensate for deflections and manufacturing inaccuracies . . . are brutes for carrying heavy loads.*

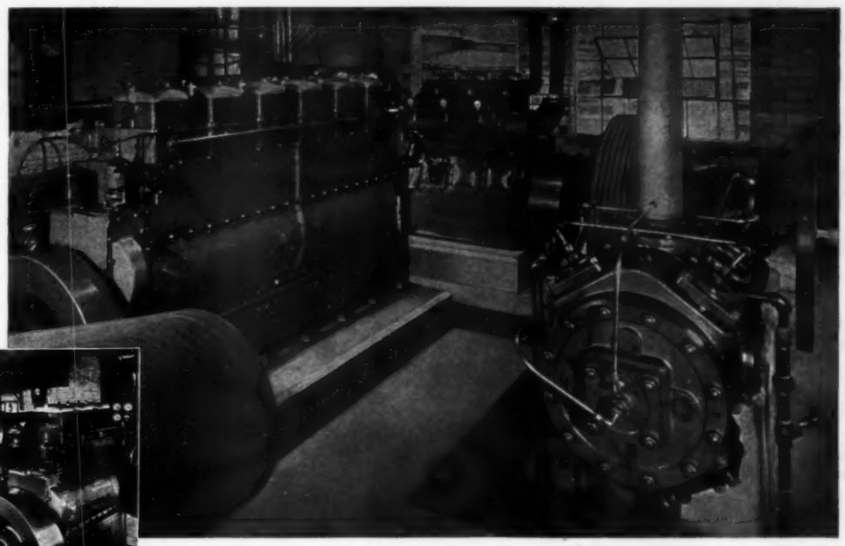
● *Use SKF wrist pin bearings for piston pin and cross head applications. They make engines quiet and trouble-free by carrying high unit pressures with minimum lubrication.*

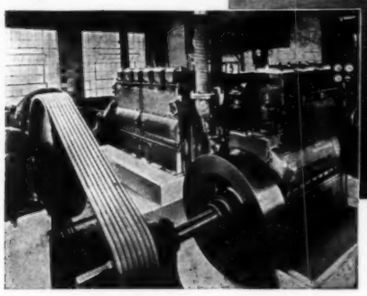
● *Use SKF ball and cylindrical roller bearings on your camshafts. They assure smooth operation, minimum maintenance, and long life.*

● *Use SKF ball, cylindrical roller and spherical roller bearings on accessories and accessory drives. Their endurance and smooth performance will justify your confidence in them.*

Another Worthington Diesel Engine Installation is Reducing Power Costs for its Owners

This modern installation at The Moore Brothers Company's Elizabeth, New Jersey, general machine shop and foundry is completely Worthington . . . . including all auxiliaries. At the left of the larger picture is a Worthington 180-hp. Diesel, driving a generator. In the background is a Worthington 90-hp. Diesel driving the Worthington horizontal feather-valve air compressor shown in the right foreground. Both generator and compressor are driven through Worthington Multi-V-Belt drives. Another view of the engines, also the Multi-V-Belt compressor drive, is shown below.





. . . contributing substantially to profitable plant operation

This experience of the Moore Brothers Company is typical of Worthington engine economy, consistently demonstrated in a wide range of applications. In some plants, power costs have been reduced more than 50%.

BY installing a Worthington engine now, you can effect comparable power savings which will directly augment your future profits. A Worthington engineer will be glad to study your power problem, and submit complete recommendations to meet your exact requirements.

●

Worthington engines are built for continuous operation at medium speeds. A complete line provides the correct unit for every individual condition . . . and Worthington air compressors for starting, rotary pumps for fuel transfer, and centrifugal pumps for jacket cooling, give additional service security through the undivided responsibility of one maker.

DIESEL ENGINES . . . 50 to 1500 hp.
Every type of drive

OTHER WORTHINGTON PRODUCTS

AIR CONDITIONING EQUIPMENT
REFRIGERATION AND ICE PLANT EQUIPMENT
AIR AND GAS COMPRESSORS
STEAM ENGINES
STEAM TURBINES
STEAM CONDENSERS
STEAM-JET EJECTORS
FEEDWATER HEATERS
PUMPING EQUIPMENT
V-BELT DRIVES
LIQUID METERS
ROCK DRILLING EQUIPMENT
CONTRACTORS AIR TOOLS

Literature on request

WORTHINGTON PUMP AND MACHINERY CORPORATION

General Offices: **HARRISON, NEW JERSEY** - *Branch Offices and Representatives in Principal Cities throughout the World*

WORTHINGTON

ATLANTA BOSTON BUFFALO CHICAGO CINCINNATI CLEVELAND DALLAS DENVER DETROIT EL PASO HOUSTON KANSAS CITY LOS ANGELES NEW ORLEANS NEW YORK PHILADELPHIA PITTSBURGH ST. LOUIS ST. PAUL SAN FRANCISCO SEATTLE TULSA WASHINGTON

D87-8A

Nothing but the Best is good enough for the fire service.

A NUGENT OIL FILTER PROTECTS EACH PUMPING ENGINE ON CHICAGO'S NEW FIRE BOAT the "FRED A. BUSSE"

• Each of the 5 Cummins 250 H.P. Diesel Pumping Engines is protected by a Nugent Large Area (Patented) Oil Filter.

All the oil in circulation is filtered every cycle before going to the bearings.

Thus the dirt, abrasives, etc. are removed as soon as they get into the oil—not by-passed for several rounds.

A like installation is aboard Detroit's new fire boat "John Battle"

Wm. W. Nugent & Co., Inc. Mfrs.
Oil Filters, Oiling and Filtering Systems, Telescopic Oilers, Oiling Devices,
Sight Feed Valves, Flow Indicators, Compression Union Fittings, Oil Pumps, Etc.
415 N. Hermitage Ave. Established 1897 Chicago, U. S. A.

WHEN YOUR MACHINE WAS JUST A PIECE OF PAPER

Its Lubrication was as carefully planned as its size, weight and balance... and the chances are 4 to 1 that Socony-Vacuum Lubricants were approved for its use!

WHEN THE MACHINES in your plant are planned ...chances are that Socony-Vacuum engineers "sit-in." And very likely Gargoyle Lubricants are recommended for their efficient lubrication.

Here are good reasons why 80% of America's machinery builders approve the oils and greases trade-marked with the Red Gargoyle: they offer power savings, decreased maintenance, improved production, lower annual oil bills.

110 different industries—standardize on Gargoyle Lubricants. Their reasons: better machine efficiency and savings in plant operating costs.

Encourage your staff to cooperate with Socony-Vacuum engineers. You will find it profitable.

SOCONY-VACUUM

INDUSTRIAL LUBRICATION

GARGOYLE Lubricants

SAVES MONEY FOR INDUSTRY

71 Years' Lubricating Experience... the Greatest in the Oil Business

Giant FIRE FIGHTER

POWERED BY CUMMINS

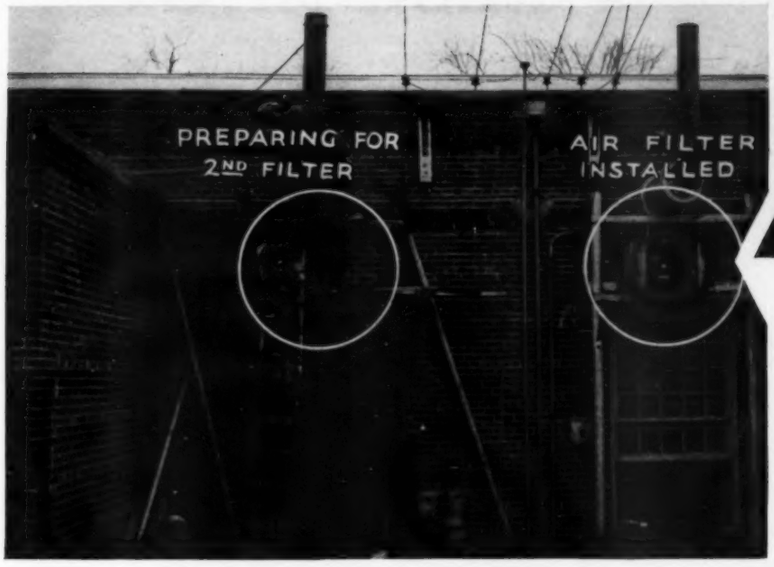
For its new fire-boat—Chicago needed Diesels with a PROVEN record of dependability, cold starting, smooth running, maximum fuel economy. All these, they found amply demonstrated in the fire-boats, City of Portland and James Battle. ❍ The selection of five 250 h.p. Cummins Diesels for main propulsion and an adequate water supply, and a Model H for generating, in the new, giant fire-fighter Fred A. Busse is highly significant. Again the Cummins Diesel is chosen on its "Record of Performance." ❍ Ask your Cummins dealer for the performance record in boats similar to your own . . . see if you can be satisfied with anything less than Cummins Diesels in your boat.

CUMMINS ENGINE COMPANY, 1520 WILSON STREET, COLUMBUS, INDIANA

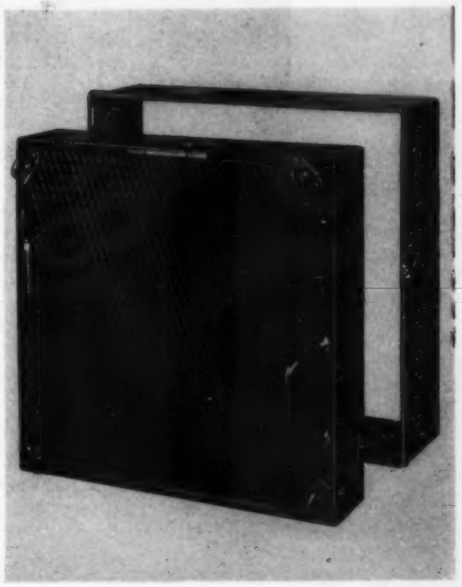
CUMMINS DIESELS

Pioneers in Modern Diesel Development

All set for a second AMERICAN AIR FILTER



Standard for over 14 years—today, in these new American Filters, all filter cells are interchangeable.



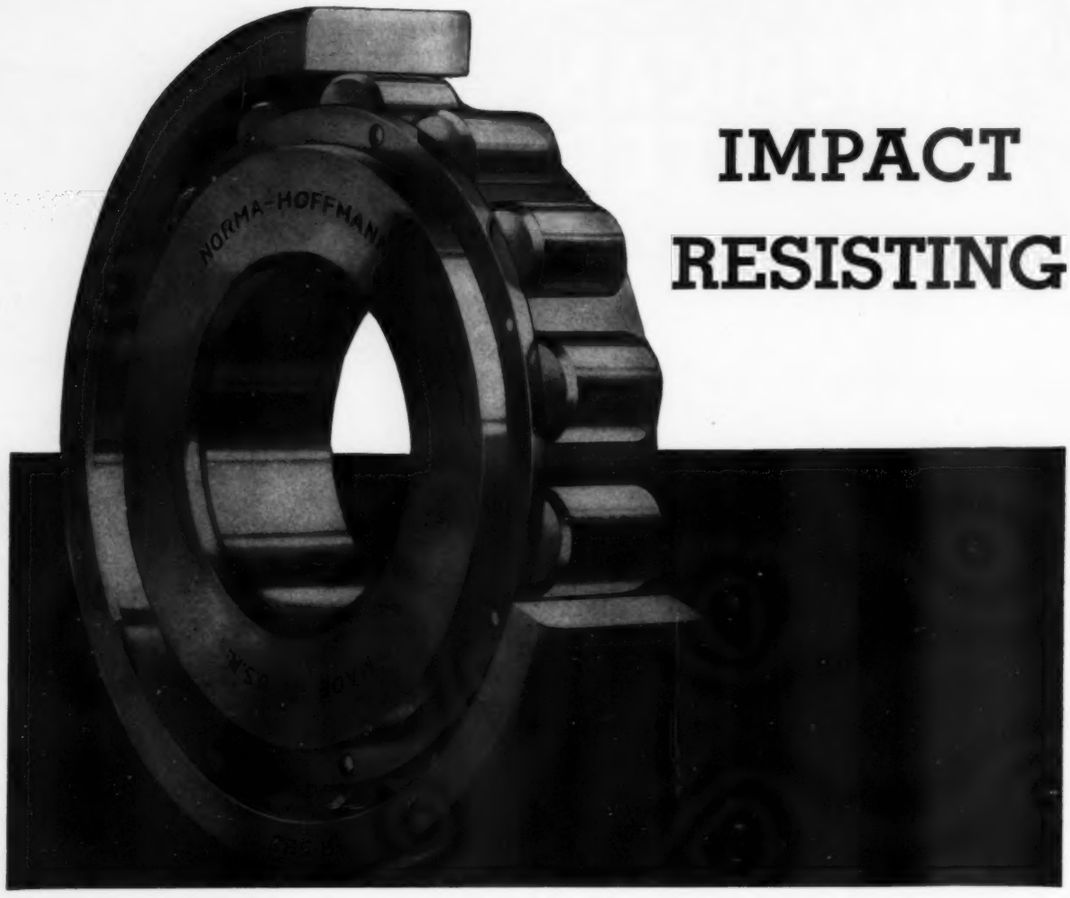
Write for Bulletin No. 120B—or let us know when we can help you on any problem on air filters.

Gainesville, Texas, Believes in Sticking to a good thing—They are installing a SECOND American Air Filter . . .

If the proof of the pudding is in the eating, the proof of the American Air Filter is in the results obtained under actual working conditions—and when those results warrant the purchase of another American Air Filter—they must be doing a good job. Many other installations in all parts of the country under all sorts of conditions attest to their effectiveness in keeping dirt out of Diesels. Specify "American" when you buy an air filter.

AMERICAN AIR FILTER CO., Inc.
INCORPORATED
280 CENTRAL AVE. LOUISVILLE, KENTUCKY
In Canada: Darling Bros. Ltd., Montreal, P. Q.

AMERICAN AIR FILTERS



IMPACT RESISTING

WHERE service conditions are most severe—where loads are heaviest —where impact, momentary overloads, and vibration are a problem—there NORMA-HOFFMANN PRECISION ROLLER BEARINGS demonstrate their extraordinary ability to absorb punishment.

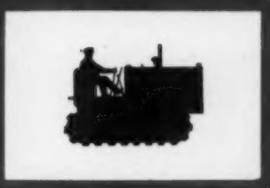
Short parallel roller design—the use of a heavy-duty, completely machined bronze retainer—extreme refinement of workmanship and finish—these factors combine to give these PRECISION Roller Bearings a lower coefficient of friction under heavy loads than any other type of ball or roller bearing, together with a speed-ability equal to that of any ball bearing, size for size. Write for the Catalog. Let our engineers work with you.

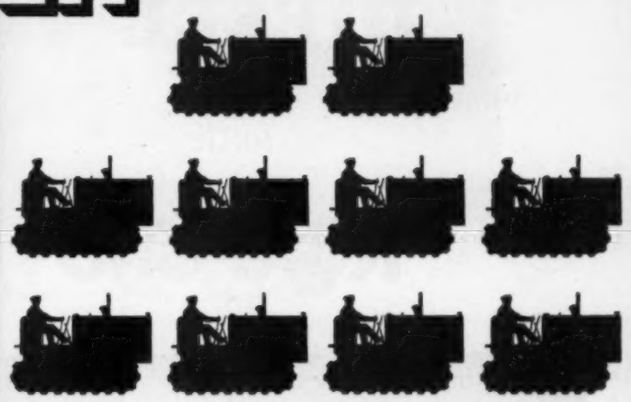
"NORMA-HOFFMANN"

PRECISION BALL, ROLLER and THRUST BEARINGS

NORMA-HOFFMANN BEARINGS CORPN., STAMFORD, CONN. U.S.A.

Multiply Diesel Service Hours by TEN with SINCLAIR TEN-OL





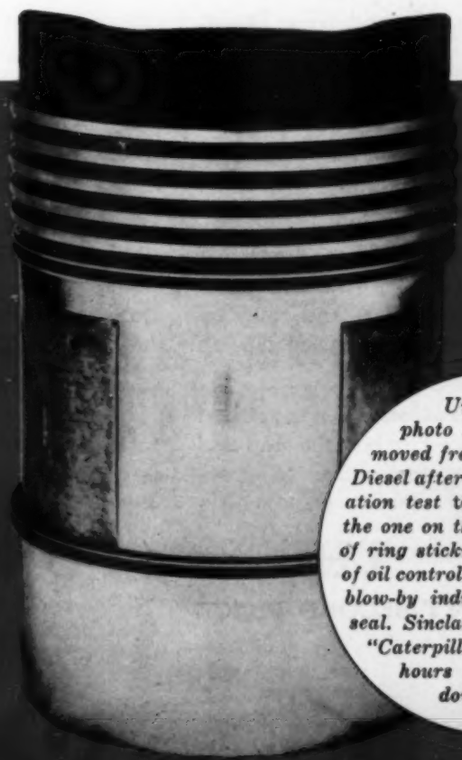
How would you like to get ten times more service hours between shutdowns with your "Caterpillar" Diesel? You can if you use Sinclair Ten-ol, the new alloyed lubricating oil developed by Sinclair.

In full power comparative laboratory tests using "Caterpillar" Diesels, Sinclair Ten-ol was compared to the finest straight mineral oil. Ten-ol gave ten times more service hours without shutdown than the high grade straight mineral oil. In the average of all tests, consumption of Ten-ol was approximately one-half that of high grade straight mineral oils.

Sinclair Ten-ol is recommended by the Caterpillar Tractor Company as a "new outstanding Diesel engine lubricant." Order Sinclair Ten-ol, Sinclair Diesel fuel and other Sinclair products from the local Sinclair office or write to Sinclair Refining Company (Inc.), 630 Fifth Avenue, New York City.

Copyrighted, 1937, by Sinclair Refining Company (Inc.)

Unretouched photo of piston removed from a "Caterpillar" Diesel after an accelerated operation test with finest straight mineral oil. Note carbon-coated piston crown, sludge, plugged oil control rings and gum on piston skirt, and evidence of excessive blow-by, resulting from poor piston seal.



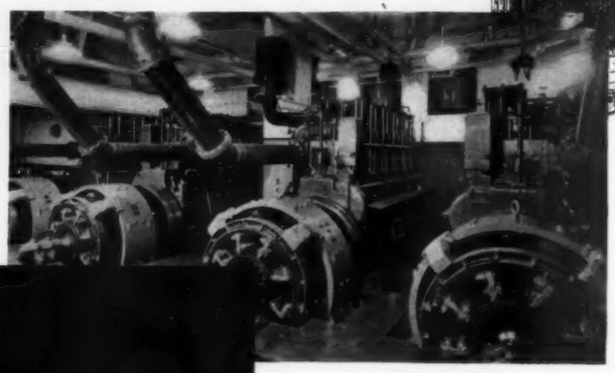
Unretouched photo of a piston removed from a "Caterpillar" Diesel after an accelerated operation test ten times as long *as the one on the left. Note absence of ring sticking, perfect condition of oil control rings. Freedom from blow-by indicates proper piston seal. Sinclair Ten-ol multiplies "Caterpillar" Diesel service hours between shutdowns by ten.*

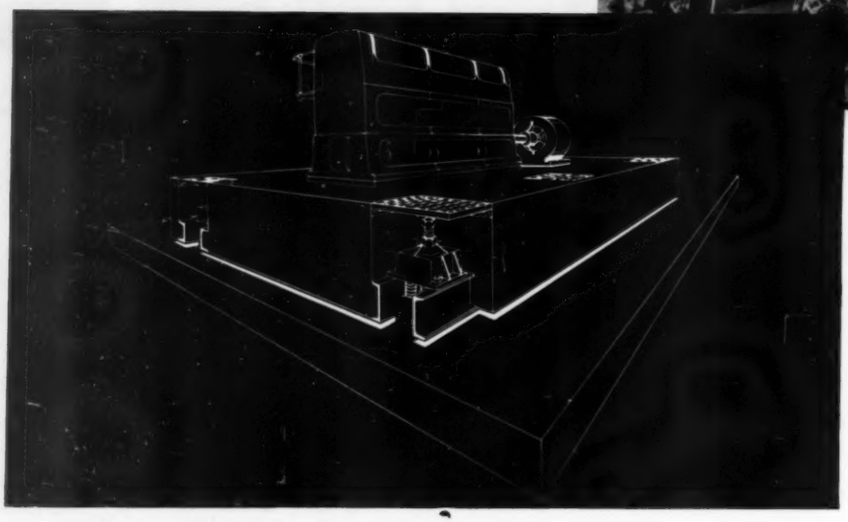
Isolate . . .

DIESEL VIBRATIONS

with

KORFUND ANTI-VIBRATION PRODUCTS





At Two Park Avenue the **new** Korfund Type U Vibro-Dampers eliminate transmission of vibrations from four 6 cylinder 4 cycle 450 HP Worthington Diesel engines direct connected to Crocker Wheeler 300 KW generators running at 327 RPM.

Vibrations transmitted from Diesel engines are destructive, costly and unnecessary.

Control vibrations from the Diesel engine installed in a hotel or office building and there will be no complaints from tenants.

Control vibrations from the Diesel engine installed in an industrial plant and save dollars and cents by relieving workers of undue fatigue and strain.

Control vibrations from the Diesel engine installed on board a ship and eliminate the destruction to structural parts and the annoyance their wanderings cause.

Control vibrations on any Diesel engine installation and reduce maintenance bills by lowering wear and tear on engine parts.

For the last thirty years and on over 200,000 installations Korfund *Anti*-Vibration Products have successfully prevented the transmission of machinery vibrations.

Two Park *Avenue* Building, N. Y.; The Namm Store, Brooklyn; Village of Rockville Centre, N. Y.; University of Texas; Sailors Snug Harbor, N. Y.; Brevoort Garage, N. Y.; Mt. Palomar Generating Plant, California; Hotel New Yorker; New York University; Corning, Iowa, Light Plant; R. H. Macy & Co., N. Y.; and many U. S. Navy ships and private yachts are just a few of the Diesel engine installations where Korfund *Anti*-Vibration Products eliminate vibration transmission.

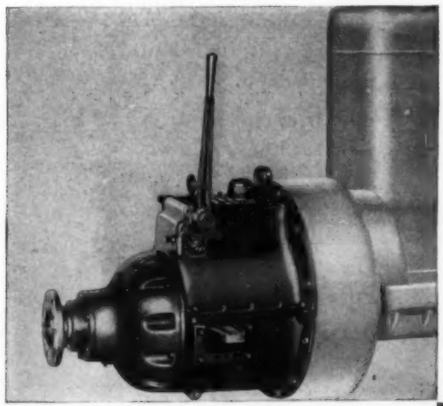
Vibrations transmitted from Diesel engines are destructive and costly and annoying. Eliminate them efficiently and economically with Korfund *Anti*-Vibration Products. Write for complete details.

THE KORFUND COMPANY, Inc.

4826 THIRTY-SECOND PLACE — LONG ISLAND CITY, NEW YORK, N. Y.

The tug *La Russie* . . . owned and operated by Grecian Cheramie, Golden Meadows, La., and chartered by the Texas Oil Co. of La. . . . transports drilling supplies between warehouses of the company along the southern coast of Louisiana. She also barges oil from the wells to the open water where it can be handled by tank ships. It pulls two loaded barges, each 28 ft. by 120 ft., in dead water, in a 10-ft. channel, at 5 m.p.h. Towing one barge it makes 6.5 m.p.h.

The *La Russie* is powered with a Fairbanks-Morse Model 36, 60-hp., 6-cylinder, 4-cycle, medium speed and medium weight Diesel Engine, with an MG-60 Twin Disc Marine Reverse and Reduction Gear Unit, and has a specially designed F-M, 33-in., ovoid non-cavitating propeller.



Twin Disc Marine Reverse and Reduction Gear Unit Model MG-60 (above) is rated 60 hp. at 1200 rpm; standard gear ratios, 2:1 or 2½:1. Model MG-160 is rated 160 hp. at 1200 rpm; 2:1 or 3:1. Gear ratio in reverse is same as forward ratio in both models.

FULL SPEED

Ahead or Astern

DIRECT PILOT HOUSE CONTROL

One of a fleet of boats chartered by the Texas Oil Co. of Louisiana, to transport drilling supplies and oil—this lugger type tug *La Russie* is 45-ft. long, with a 10-ft. beam and a 3-ft. 6-in. draft aft. Now powered with a 60-hp. Fairbanks-Morse Diesel Engine with an MG-60 Twin Disc Marine Reverse and Reduction Gear Unit, the *La Russie* can be maneuvered with far greater ease and speed.

With the Twin Disc Reverse Gear Unit, it has full speed astern as well as ahead. And the pilot can instantly alter his speed or change his direction ahead or astern direct from the pilot house. The *La Russie* can turn in closer quarters and has less draft than any other similar craft in the area.

Differing materially from conventional type conversion units, Twin Disc Units are unusually simple in design—two clutches . . . five gears . . . with large size, extra capacity, anti-friction bearings throughout. Especially selected for marine service, the clutches are of the close coupled, multiple disc type, operating in oil. Reduction unit is built into reverse gear. Reverse speed is 100% of forward speed. Twin Disc Marine Reverse and Reduction Gear Units are made in 60 hp. and 160 hp. models. *Write for descriptive bulletins.*

TWIN DISC CLUTCH COMPANY

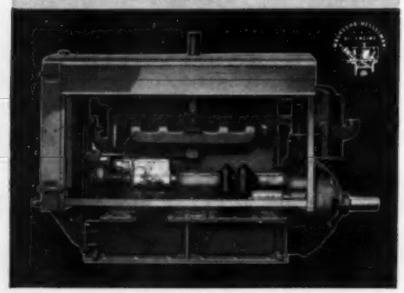
1345 RACINE STREET — RACINE, WISCONSIN

MARINE REVERSE AND REDUCTION GEAR UNITS

TWIN DISC
CLUTCHES

YOU NEED REAL HORSEPOWER

WAUKESHA ENGINES



● **The engine that drives gravel plant machinery must have *real* horsepower. The horsepower shown on some performance curve won't turn over a single piece of equipment, if it isn't in the engine.**

In the Hartland-Verona Gravel Co. operation at Verona, Wis., the power for driving all equipment is generated in the crushing plant. A 6-cyl., 125-185 hp. EKU Waukesha-Hesselman Oil Engine drives the crushing plant machinery direct, while, at the same time, the washing plant screens and two pit conveyors are driven by motors which receive their current from a 40 kv-a generator, also driven by the engine.

The Hesselman Engine has a sheave for 13 V-belts on its shaft. Nine of them connect to the driving mechanism of the primary crusher, three drive the generator and one the exciter. A system of chains and sprockets from the primary crusher drives the secondary crusher, return bucket, vibrating screen, conveyor over the screen and washing plant conveyor, from its tail pulley. The rest of the mechanical equipment, except the pump, is motor driven.

This Waukesha-Hesselman Engine is operating on No. 2 burner oil, using an average of 9 gal. per hour. A low compression, solid injection oil engine, with precisely timed electric ignition, the Waukesha-Hesselman Engine burns "modern high speed diesel fuels" with high efficiency; yet weighs no more than, and starts as easily as, a gasoline engine. Real horsepower . . . not paper horsepower. Write for Bulletin No. 1000.

WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN
NEW YORK • TULSA • LOS ANGELES

4 *Crocker-Wheeler* GENERATORS at NUMBER TWO PARK AVENUE

NEW YORK CITY

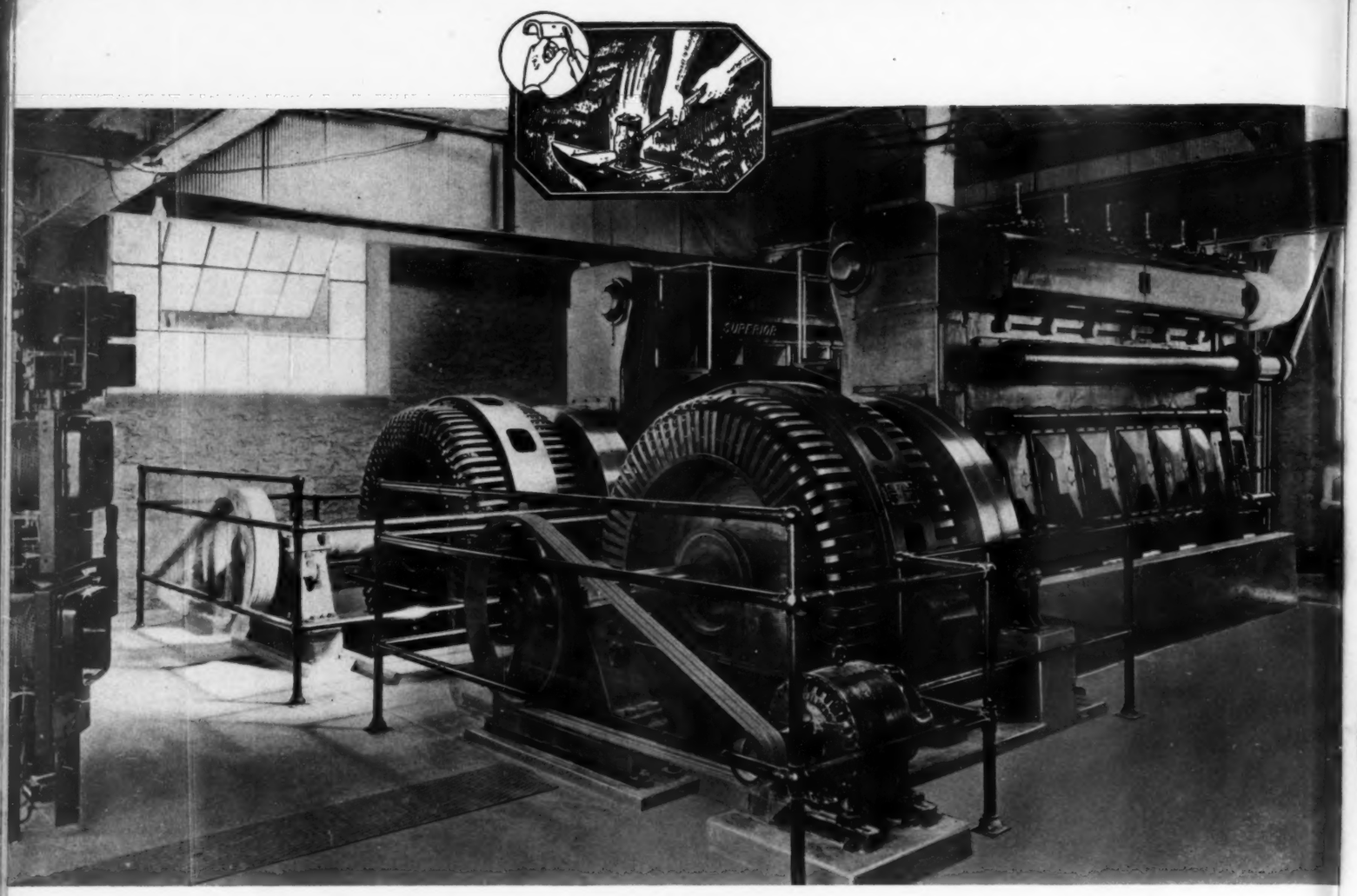
One more important installation to add to the already long list of private power plants that are depending upon Crocker-Wheeler generators for light and power. Recent installations, in New York City alone, include:

Number 580 Fifth Avenue
Hotel New Yorker
Amalgamated Housing Apartments
R. H. Macy & Co., Inc.
The Ice Club
Academy Gardens Apartments
Cascade Laundry
A. I. Namm & Son

CROCKER-WHEELER ELECTRIC MFG. CO.

Main Office and Works: AMPERE, N. J.

Sales offices in principal cities



PRO PLURIBUS UNUM

(FOR THE MANY, ONE)

MANY and varied are the jobs turned over to Diesels. They range all the way from driving airplanes to crushing rock. Take the installation pictured above as a case in point—Superior Diesels manufactured by National Supply Company, Springfield, Ohio, for the Columbia Quarry Company, Krause, Illinois. Digging and crushing rock is a prosaic job, to be sure, but the task of supplying the power to do the work is none the less important. As is to be expected, the National-Superior Diesels are carrying out their assignment: dependable, economical operation. PRO PLURIBUS UNUM is a motto that fits Satco* too. This modern bearing alloy has what it takes to give top performance not only in this Superior Diesel installation but also in numerous other instances across the country. Satco bearing metal, plus ABC engineering and production facilities, may be the right answer to YOUR bearing problem.

*A patented alloy manufactured by National Lead Company. Trade-mark registered.

AMERICAN BEARING CORPORATION

AFFILIATED WITH NATIONAL LEAD COMPANY

INDIANAPOLIS CENTRIFUGAL American Bearings FORCE INDIANA

ERIE

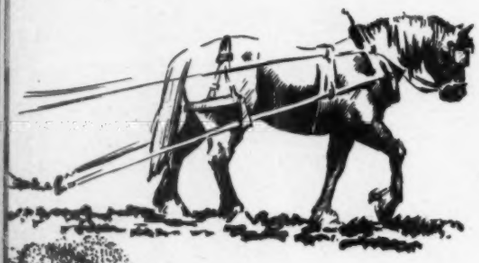
Crankshafts selected by Nordberg Manufacturing Company for the five cylinder, 1250 h. p. engine recently installed in this Municipal Plant.

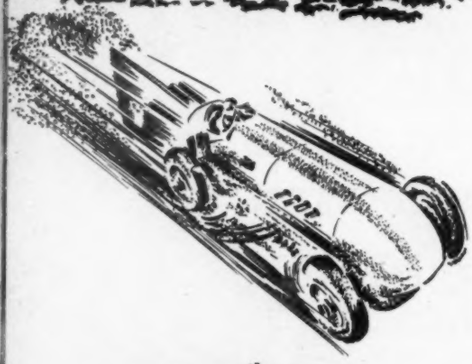
MARSHALL, MICHIGAN BUYS ANOTHER NORDBERG

Because of their superior quality and accurate finish all leading engine builders rely upon Erie crankshafts and other forged parts entering into the construction of stationary and marine engines. Complete facilities for prompt delivery on all major forged or cast steel elements required in the building and powering of every type of installation.

ERIE FORGE COMPANY, ERIE, PENNSYLVANIA

SLOW SPEED *Means Long Life!*





Speed is the heritage of the thorough-bred, a high spirited animal whose value is determined by his winnings at the race track. In a few short seasons his work is done—retired with honors, or wind-broken, he passes into oblivion.

The draft horse is bred to do the world's work. With a heavier frame, he is not as picturesque as the race horse. He may be just a "plug," but for twenty years he may render a dependable service.

The racing car is designed with but one idea in mind—to finish a race in winning time. The engine is "souped up" to deliver a maximum R.P.M. Constantly in need of tuning, it spends more time in the shop than on the track.

The dump truck is built to carry the heavy burdens imposed by the construction industry. Sturdy in construction and with an engine designed for heavy-duty service, the dump truck remains in service for years after the wreckers have sold the parts of the racing car.

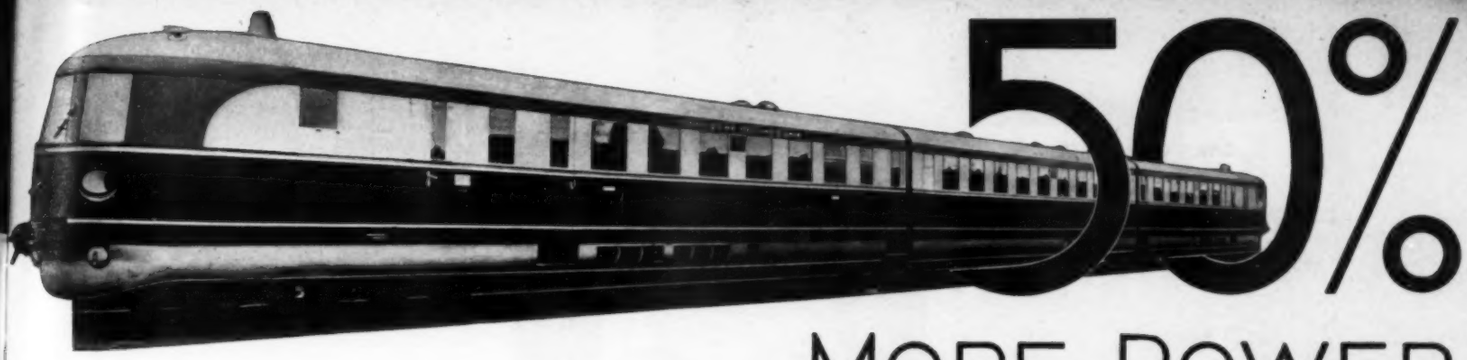
The speed boat is a thriller to the sportsmen who like the water. Light in weight and finely polished, with a high speed engine with which she skims the water, she is a constant source of work, worry and repairs.

The heavy duty workboat, powered by a slow speed Atlas Diesel, is destined for many years of economical, continuous service. Speed is sacrificed for Dependability—that's why you see the Atlas Diesel powered boats plying the rivers, harbors, bays and inland waterways, when boats with high speed engines are tied up for repairs.

ATLAS IMPERIAL DIESEL ENGINE CO.
OAKLAND, CALIFORNIA • MATTOON, ILLINOIS

ATLAS IMPERIAL

DEPENDABLE DIESEL POWER FOR THE WORK BOAT OWNER



50%

MORE POWER

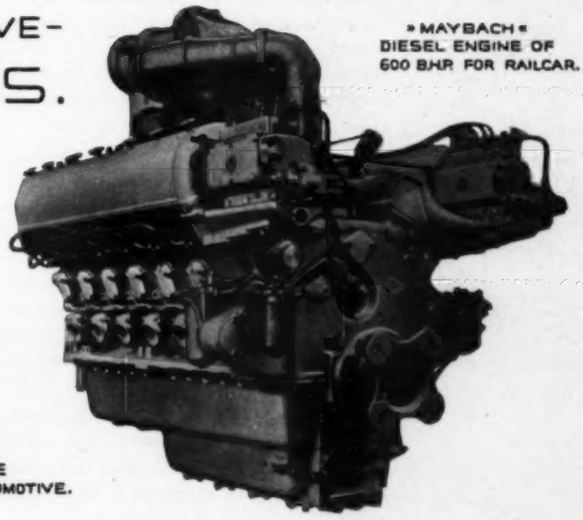
WHEN USING THE PATENTED SYSTEM OF

Buchi

TURBOCHARGING

FOR STATIONARY - MARINE - AND AUTOMOTIVE -

DIESEL ENGINES.



»MAYBACH« DIESEL ENGINE OF 600 B.H.P. FOR RAILCAR.

MINIMUM : SPACE AND WEIGHT
COOLER DIMENSIONS
FUEL CONSUMPTION

»M·A·N« DIESEL ENGINE OF 1400 B.H.P. FOR LOCOMOTIVE.

MAXIMUM : OVERLOAD CAPACITY
STARTING TORQUE
RADIUS OF ACTION
ACCELERATION

ALFRED J. BUCHI

ENGINEERING OFFICE
WINTERTHUR / SWITZERLAND

GENERAL LICENSEES:

Messrs. BROWN, BOVERI & CIE. A. G., Baden
" COOPER-BESSEMER CORP., Mt. Vernon, U. S. A.
" HARLAND & WOLFF, LTD., Belfast
" HUMBOLDT-DEUTZMOTOREN A. G., Köln.
" JOHN G. KINCAID & CO., LTD.; Greenock.
" MASCHINENFABRIK AUGSBURG-NÜRNBERG A.G., Augsburg.
" NORTH EASTERN MARINE ENGINEERING CO., LTD., Wallsend.
" GEBRÜDER SULZER A. G., Winterthur.
" SCHWEIZ. LOKOMOTIV- & MASCHINENFABRIK, Winterthur.
" FRANCO TOSI S.A., Legnano.
" WERKSPOOR N.V., Amsterdam.
" BROWN, BOVERI & CIE A.G., Mannheim.
" CIE. ELECTRO-MÉCANIQUE, Paris.
" RICHARDSONS, WESTGARTH-BROWN BOVERI, LTD., Hartlepool.

INDIVIDUAL LICENSEES:

Messrs. ACIÉRIES DU NORD S.A., Hautmont.
" AMERICAN LOCOMOTIVE CO., Auburn, N.Y., U.S.A.
" W. G. ARMSTRONG, WHITWORTH & CO., LTD., Newcastle.
" BALDWIN-SOUTHWARK CORP., Philadelphia, U.S.A.
" DAIMLER-BENZ A.G., Untertürkheim & Gaggenau.
" DAVEY, PAXMAN & CO., LTD., Colchester.
" DENNIS BROS., LTD., Guildford.
" DEUTSCHE WERKE KIEL AKTIENGESELLSCHAFT, Kiel.
" A.G.d.EISEN- & STAHLWERKE VORMALS GEORG FISCHER, Schaffhausen.
" A/S FRICHS, Aarhus.
" GRAZER WAGGON- & MASCHINENFABRIKS-A.G., Wien.
" HENSCHEL & SOHN A.G., Kassel.
" INTERNATIONAL-PLAINFIELD MOTOR CO., Plainfield, U.S.A.
Messrs. KOCKUMS MEK. VERKSTADS A/B, Malmö.
" KOLOMNA ENG. WORKS, Golutwin.
" FRIED. KRUPP, GERMANIAWERFT A.G., Kiel.
" L. LANG, MASCHINENFABRIKS-A.G., Budapest.
" LEYLAND MOTORS LTD., Leyland.
" MAYBACH-MOTORENBAU G.m.b.H., Friedrichshafen.
" MIRRLEES, BICKERTON & DAY, LTD., Stockport.
" MITSUI-BUSSAN K.K., Kobe.
" MOTORENWERKE MANNHEIM A.G., Mannheim.
" NATIONAL GAS & OIL ENGINE CO., LTD., Ashton-under-Lyne.
" NIIGATA ENGINE WORKS, Tokyo.
" NORDBERG MANUFACTURING CO., Milwaukee, U.S.A.
" THE OTTO ENGINE WORKS, Philadelphia, U.S.A.
" RUSTON & HORNSBY LTD., Lincoln.
" A. SAURER A.G., Arbon.
" SCOTTS' S.B. & ENG. CO., LTD., Greenock.
" TOSI-DUJARDIN S.A., Lille.
" WINTON ENGINE CORP., Cleveland, U.S.A.

NO. 3 OF A SERIES

Is this man worth 10 minutes of your time?

FOR two years he has planned to secure a ten-minute interview with you. He has invested $1,000, more or less, in himself—a result of saving and sacrifice. He gave up a job; stopped earning money; dedicated his entire time to justify a request for ten minutes of your time.

Many successful men in the Diesel and Gas Engine Industries have won their laurels in the "practical school of hard knocks." They fought their way to the top by sheer grit and determination. You, as one of the successful Diesel men, are now at or near the top. Our young man pictured on this page is another "You"—the "You" of five, ten or twenty years ago. He, too, has the same "stuff" in him, the same pioneering spirit that you recognize in the man who has made good.

Two years ago he became determined to enter the Diesel Industry. He knew he was mechanically inclined, but lacked knowledge and experience. He knew he must be prepared if he was to "make the grade."

What did he do? Instead of looking for a job for which he was not then qualified and without imposing a burden on the busy Diesel Industry, he took steps to prepare himself. He saved and sacrificed until he had sufficient funds. Then he sought a group of experienced, practical Diesel men to work for him, to guide him and to teach him what he lacked. He put these men to work six hours a day for nearly a year. To him it was like getting a successful Diesel man such as yourself, to pass on to him all of the knowledge gained in the climb to success in the Diesel Industry. At the same time he worked on all types of Diesel Engines and equipment under the watchful eyes of those who were paid to train him. *Yes, he went to a Diesel trade school* but he paid his own way at absolutely no cost to the Diesel Industry.

Isn't this young man worth something to you? He wants a chance, an opportunity to start just as you started years ago. He is not yet a *finished* product but he has the fundamental technical knowledge and the real incentive of making a valuable employee to you who seek loyalty and initiative in the man you hire.

We think this man is worth ten minutes of your time. He is entitled to a chance in the Diesel Industry.

●

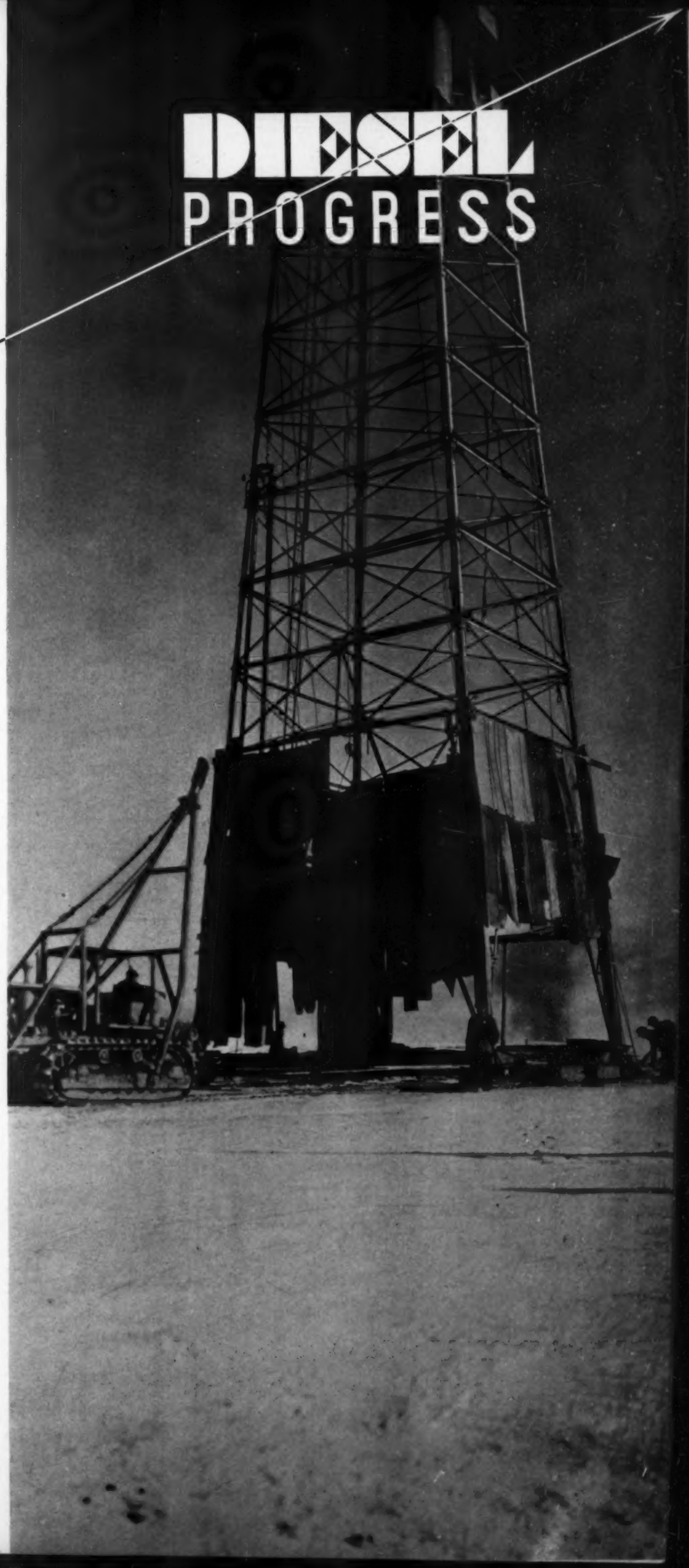
In your need for such a man we are pleased to make available his services with our fullest recommendation. National Schools is endeavoring to place with the Diesel Industry young men who have been carefully trained by the most practical methods. National Schools was established in Los Angeles in 1905 and has continued without interruption under the management of its founders, with a definite policy of honesty, sincerity and worthiness of purpose. Today, National Schools, representing a million-dollar investment, offer sound, thorough instruction courses in Diesel and Gas Engine work and Radio and Electricity.

NATIONAL SCHOOLS

4000 South Figueroa Street • Los Angeles, California

{PIONEERS OF PRACTICAL TRAINING FOR 32 YEARS}

DIESEL PROGRESS



CONTENTS FOR APRIL

	PAGE
No. 2 PARK AVENUE	22
DIESEL MOBILE ICE PLANT	26
COOPER, TEXAS	28
THE OLD SAW MILL GOES DIESEL	30
CARMELITE	32
DIESEL ENGINES (No. 2)	33
LONDON LETTER No. 17	37
DIESEL AIRCRAFT ACTIVITIES	40
CHICAGO DIESEL FIRE BOAT	42
DIESEL FLOOD SERVICE AT LOUISVILLE	44
SISCO DAIRY DIESELS	46
DIESEL ENGINE VIBRATION CONTROL	47
SPECTRUM ANALYSIS, A MODERN AID IN DIESEL ENGINEERING	57

TABLE OF CONTENTS—A rotary oil rig in the process of being skidded one mile across country by a Caterpillar Diesel at Lance Creek Field, Wyoming.

DIESEL PROGRESS for April, 1937, Vol. III, No. 4. Published monthly by Diesel Engines, Inc., 2 West 45th St., New Yrk, N. Y. Tel. MUrray Hill 2-5092.

Subscription rates: U.S.A. and Pan American Countries $3.00 per year; 25c per copy. Canada and all other countries, $5.00 per year; 50c per copy.

NUMBER TW

ER TWO PARK AVENUE

By JOHN W. ANDERSON

AT number 2 Park Avenue stands the 28-story office building known as the Park Avenue Building. Up to the present time it has depended upon the local utility for its electric power requirements, but it has recently generated its own steam for heating needs with considerable savings. The building was designed to have the steam flow directly to the top of the building, before it feeds down through to the radiators. The boilers were installed new for oil-firing. The original building construction contemplated coal fired boilers and a coal bunker was provided but never used.

As was the practice at the time of construction, this building was originally wired to use direct current for all of its needs. Due to a load increase the building management faced a problem since it was against the policy of the utility to accept increases in direct current loads. Influenced by the economy of the Diesel engines, the building management decided to install their own power plant.

And right at this point one of the advantages of the Diesel engine came out most prominently, its adaptability. For there was a serious problem of finding the necessary space for the new equipment and overcoming the local problems of installations without sacrificing anything in the way of accessibility or dependability. But all of these problems have been successfully solved. All outside power connections have been severed, the power plant is entirely self sustaining, and many of the tenants of the building are quite unconscious of the source of the power, or the presence of the new power plant, due to its quiet and efficient operation to date.

The best space available was that occupied by the old coal bunker at one side of the building, and which extended partly under the street sidewalk. At this point there is a ramp into an interior areaway for trucks to deliver and to take away goods for the tenants. Since this ramp is over part of the engine room it provided an easy way of introducing the machinery. The hatchway in the ramp, which is large enough to get the egines in completely assembled, was buit especially to facilitate the Diesel installation.

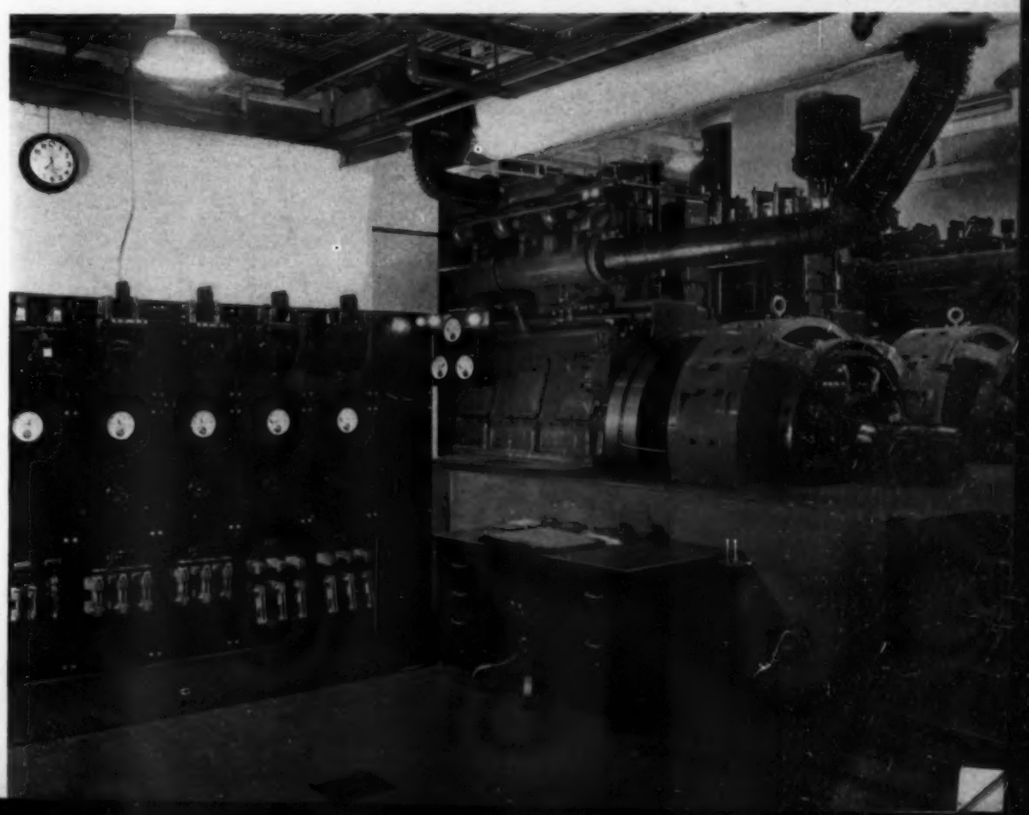
At present there are four Diesel generator units all of the same capacity alongside of each other, but there is room for a fifth in another part of the room and the sub foundation for it has been installed. Each unit is a six-cylinder 450 hp. Worthington Diesel direct connected to a two wire Crocker Wheeler 300 kw. 250 volt direct current generator running at 327 rpm. The size of these units was chosen after considerable investigation. It was considered preferable to operate one large unit at reduced load during the off peak hours than to install a smaller unit for this purpose. Furthermore, with a larger unit on the line there is plenty of capacity for unexpected loads.

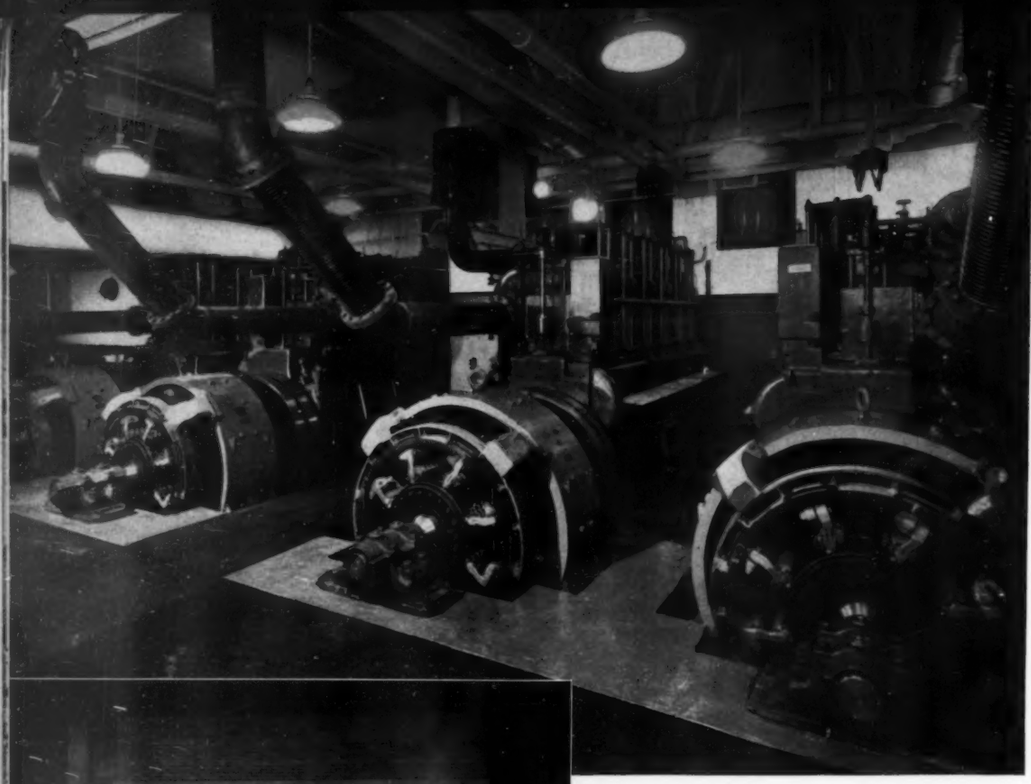
The usual night and weekend load is only about 60 kw., but an elevator comes on from time to time, and in case of fire, the fire pump with a 150 hp. motor would be thrown on immediately. With one of the main units running, there is ample capacity for all contingencies. In the day time and evening, from about 7 A. M. to around 10:30 P. M., from two to three units are always needed. The elevator system installed in the building is of the variable voltage type which includes a motor generator set for each traction motor of each elevator, with the result that the power demands on the main units are fairly steady. Power circuits are 230 volts and the lighting circuits are 110 volts. Under usual conditions the lighting circuits are pretty well balanced, but three 200 ampere capacity balancer sets are available to take care of any unbalanced conditions. Usually one of them is more than ample.

The Cole switchboard is located at the end of the boiler room but adjacent to the engine units. Cables lead from the station panel through a transite duct to the existing distribution switchboard in another room.

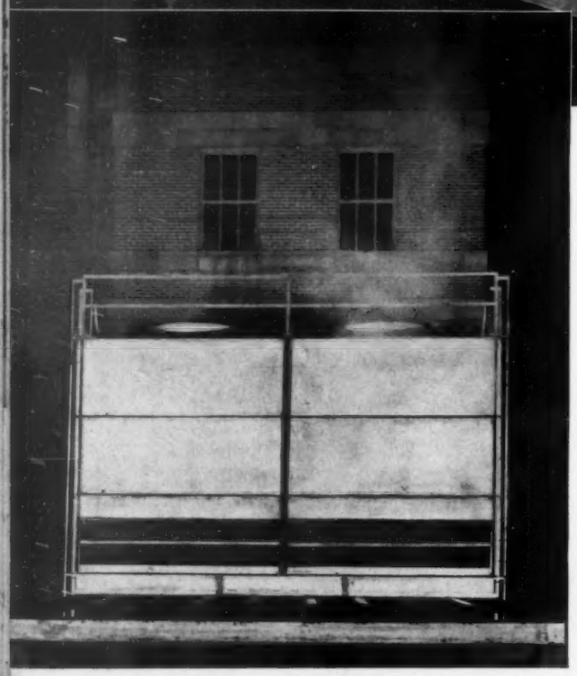
The general layout of the plant is well worked out, and the compactness without sacrifice of accessibility is obvious. The four engines are arranged in groups of two each. Each set of two engines, one a right hand and one a left hand, are installed on the same concrete slab with their operating sides facing each other. There is good walking space all around all engines.

The foundation problem was solved interestingly. Bed rock is about fifteen feet below the boiler room floor, so concrete piers were put down to bed rock and a heavy reenforced concrete mat set on top of the piers and made part of them. Above this mat and supported by it are the engine foundation blocks, but they are carried on Korfund spring vibration dampers. These foundation blocks are about three and a half feet deep and this makes the engine room floor about that much above the boiler room floor. This arrangement has proven to be entirely satisfactory. There is only a very slight tremor perceptible on the engine blocks and none at all around the engines nor in the building. All pipe lines leading to and





General engineroom view taken from the space reserved for the future Diesel unit.



On a roof balcony, two floors from the top of the building, the Binks cooling tower operates efficiently and unnoticed.

from the engine have United Metal hose flexible connections to avoid any possibility of vibration transmission through such channels.

The Worthington Diesel engines are of their standard design. Of the four cycle, trunk piston type, the inlet and exhaust valves in cages in the heads are operated by push rods from the camshaft located in the upper part of the crankcase. This camshaft also carries the cams for the individual Bosch fuel injection pumps located opposite each cylinder. Engines are equipped with Woodward governors which have speed changer, speed droop, and load control buttons. The speed droop is set to give a speed range of about from 329 to 325 rpm. from no load to full load. The speed changer is set to give exactly the same speed on all of the engines. Then the division of load among the engines is controlled by the rheostats on the switchboard.

The engine controls are all concentrated at the end of the engine opposite the flywheel. Here are the air starting controls, the mechanical lubricator for the cylinders, the Alnor pyrometer with a connection for each cylinder, and the engine pressure gauges for the lubricating oil, cooling water, and the starting air. On account of the limited space between the engine flywheels, the hand barring gear is portable and the operating lever is in the vertical position when it is in place. Each engine has a suction pipe from its crankcase, through an oil separator, to the intake header. This retains the oil vapors in the crankcase and helps to keep the engine clean.

Air for the engine room is taken from the areaway above through American air filters, is washed, and is forced into the engine room by a motor driven blower. This ensures a clean cool air supply for the engines the year around. Each engine takes its intake air from the upper part of the engine room through a Vortox intake cleaner and silencer, into the header on the engine.

Exhaust from each engine leads out from the generator end of the header, through a diagonal pipe and a section of United Metal hose flexible tubing up into the Maxim silencer overhead which leads back along the length of the engine. Then the exhaust turns at right angles and passes through a Maxim pulsation trap which is 35 feet long. Beyond these traps, the exhaust from all four engines is collected into a 24 inch diameter pipe, which runs parallel to the engines and leads back of the boilers and downward into the horizontal flue just above the boiler room floor level. The exhaust outlet pipe extends some 15 feet into this flue, which also takes the gases from the steam boilers. Then this flue runs about 50 feet horizontally, turns at right angles and runs another 50 feet, and then enters the base of the chimney which extends upward to the top of the building 29 floors above. There is never any doubt about the intensity of the draft which carries off the gases. The interesting point is the entire absence of noise and pulsations in the exhaust from the Diesel engines, which cannot be noticed at the door covering the entrance to the horizontal flue. The draft gauge on the boilers confirms this. The entire exhaust piping and muffler system is carried by spring supported hangers to avoid transmission of vibration. There are long horizontal lengths of this hot piping, and careful provision has been made for expansion.

Fuel oil for the Diesel plant and boilers is carried in three tanks.

The Diesel fuel oil, supplied by the American Oil Company, is stored in two tanks located adjacent to the engine room space and under the sidewalk, so that delivery from trucks is simple. There is one 15,000 gallon tank for the Bunker C fuel used for the boilers, and two 7,500 gallon tanks for American fuel oil for the Diesels. On the engine room wall, there are three Uehling gauges indicating the quantities of fuel in all of the tanks at all times. Main and standby motor driven fuel transfer pumps are provided, and also a hand pump for getting fuel from the storage tanks up to the 110 gallon day tanks set into the wall at the ends of the engines. These transfer pumps are arranged to take from either storage tank and deliver into the other tank, or to each of the individual engine day tanks. There is a filter between the transfer pumps and the day tanks, and another between the tanks and the engines. On the wall below the day tanks, there is an indicator for each tank to show the level of the fuel in it. And there is a Worthington fuel oil meter on the supply line to each engine.

Each engine has its own lubricating oil circuit with the sump in the bottom of the bedplate, and a built-in assembly of the rotary pressure pump and filter right on the side of the engine at the flywheel end. Texas Lubricants are used. All parts of the engine, except the valve gear which requires very little oiling, are taken care of by the one system. Then there is a mechanical lubricator for the cylinders. Periodically the oil from each engine is put through the Goulds Hydroil centrifugal purifier. The dirty oil is drained to the dirty oil tank under the floor near the purifier. The purifier takes the oil from there and delivers the clean oil to a tank overhead, and from

there it flows by gravity to any engine as desired. There is also a hand pump at floor level with a suction for attaching to an oil drum. This provides a simple method of unloading a drum of new oil directly to the clean oil tank overhead without wastage.

A closed cooling water system is used for the engines in order to avoid the heavy pressures which would prevail in the engine jackets due to the location of the forced draft Binks cooling tower on the building roof. There is a steel shell heat exchanger for the jacket water, and there are main and standby motor driven cooling water pumps on both the soft and raw water circuits. Actually soft city water is used in both circuits. The soft water pumps are rated at 360 gallons per minute at 50 feet head. The raw water pumps are rated at 540 gallons at 100 feet head. The duty on these pumps is to circulate the water against the friction head, although the raw water pumps are subjected to a static head of about 145 pounds gauge due to the building height. The soft water pumps deliver to the engines, and the return is through the heat exchanger to the pump suction. There is a 100 gallon surge tank at one end of the engine room at the high point of the system. The cooling water does not flow through the surge tank. The forced draft fan on the cooling tower is used to vary the cooling effect of the tower, and the flow volume of the raw water circuit can be choked by a valve on the pump discharge as desired. In addition all of the water pump motors are of the variable speed type. In the winter the cooling tower fan is not operated. Makeup feed from the city water supply is added to the raw water system at the cooling tower basin, and to the soft water system at the surge tank, to keep both systems full. In addition there is a connection from the city mains directly into the engine soft water system which automatically goes into action in case of a failure of the soft water supply for any reason.

All of the building heating system condensate returns to a tank located adjacent to the cooling water heat exchanger in the upper part of the engine room. Makeup feed for the boilers is taken as needed from the main cooling water return pipe from the Diesel engines, into this condensate tank. One of the minor economies but worth while.

On the Diesel engines there is a Ross lubricating oil cooler. The piping is so arranged that all, any part, or none of the cooling water can be sent through this cooler. Also, all, any part or none of the lubricating oil can be sent through. This gives a very complete control over the lubricating oil temperatures.

Engines are started by compressed air. There are two V type air cooled starting air compressor units. One of them is motor driven and automatically controlled to maintain the starting pressure at the working figure. The other compressor is driven by a Novo gasoline engine and retained for the initial and emergency charging of three large storage tanks.

Over each engine unit there is an I beam with a trolley and a half ton Chisholm Moore chain hoist to assist in maintenance work. Beyond the generators there is another I beam at right angles to the engines so that any parts can be transferred along the floor. There is a trolley and a two ton hoist on this rail, but the hoist can be transferred to any of the other trolleys over any of the engines. There is an additional beam and trolley which runs over to the work bench.

The work bench is well equipped for all of the usual minor maintenance work required, and there is special equipment for testing the fuel injection pumps and injection valves.

To help toward dependable operation, much attention has been given to safety devices. Each engine has connections to the alarm for low cooling water pressure, high water outlet temperature, low lubricating oil pressure, and high lubricating oil temperature.

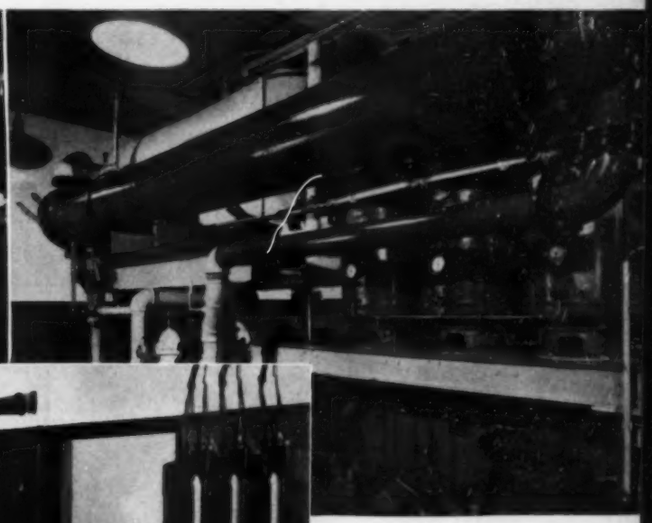
There are also alarm connections on the main cooling water return from all of the engines to the heat exchanger, for the cooling tower fan circuit, and for low water level in the cooling tower basin. All of these alarm connections lead to one klaxon horn alarm. In order that the operator may know just which point is giving trouble, there is an Edwards annunciator which shows him at a glance.

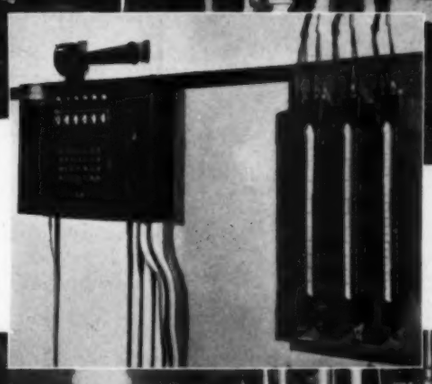
There is an independent emergency lighting circuit with individual lights well distributed around the engine room. Power for this circuit is taken from a small storage battery.

The Diesel and heating plant is operated by one man per shift with a fourth man for relief of operators who have one day off per week. The heating plant, without the electric plant, required two men during the heating season. The plant was placed in operation February first, and no actual operating figures are available as yet.

The complete plant was installed under a contract with the Worthington Pump and Machinery Corporation with subcontract work, including foundations, tanks, switchboard and electrical wiring, piping, carried out by the Diesel Electric Co., Saul Lautenberg, president, and Erwin S. Wolfson, vice president. The plant is an excellent example of the adaptability of the Diesel engine. Compactly, yet accessibly installed in the space available to give continuously dependable power economically.

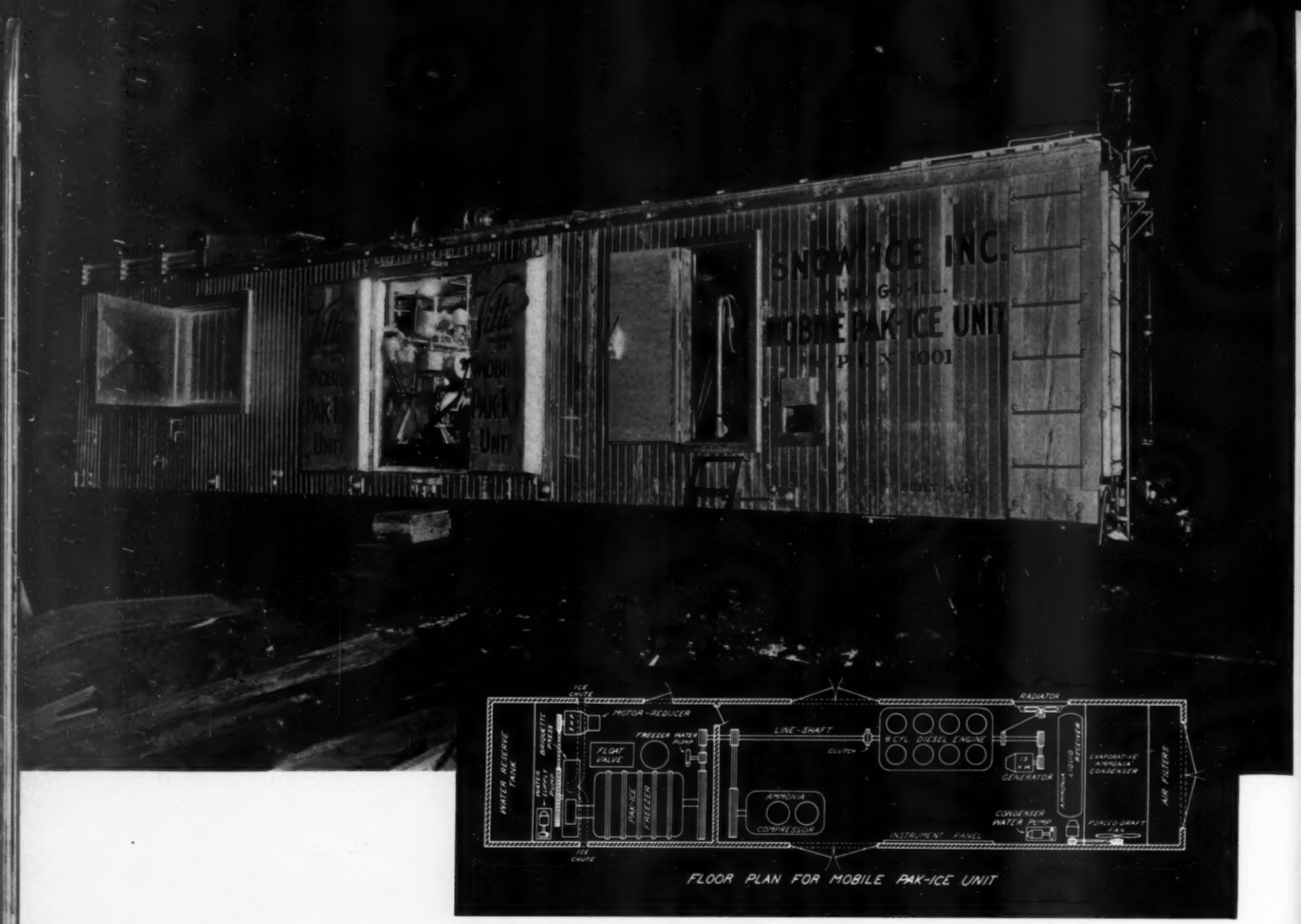
Above: A typical instrument board. Each engine carries a similar Alnor pyrometer.





Above: Auxiliary equipment such as the Ross heat exchanger, Goulds Hydroil, starting air compressors and tanks are neatly disposed of along the wall.

Center: The three Uehling tank gauges and Edwards annunciator panel.



DIESEL MOBILE ICE PLANT

DECLARED to be the first of its kind in the world, a self-contained mobile refrigeration plant all housed in a standard freight car, is now in service. The Diesel engine has been receiving considerable mention as the power for the new streamlined trains, so it should be considered fitting that the power for this new mobile ice plant, which turns out a stream of streamlined ice briquettes, should also be Diesel powered. And so it is, with a 160 hp. full Diesel "Caterpillar" engine of 8-cylinder V-type. The ice making equipment was made and installed by the Vilter Manufacturing Company of Milwaukee and consists of a Pak-Ice briquette machine, ammonia compressor, evaporative condenser, liquid receiver, generator, pumps and fuel and water tanks.

Although this outfit has been in service for only a short time, it has been found to have many advantages, two of which are economical operation and instantaneous production. It attains full capacity production in 20 minutes. Radiation, friction and crushing losses, which run as high as 25 per cent in a can ice plant, are eliminated. As to economy, when it is considered that the national average price for Diesel fuel is only 6c per gallon and that consumption averages only 4.9 gallons per ton of ice produced in this mobile plant, then it may safely be declared that this Diesel powered installation has scored a bull's-eye on this point.

This track ice unit was designed especially for icing refrigerator cars. It is entirely independent of outside power and resources, with the exception of water, and this feature permits its operation when and where desired throughout the network of United States railroads. It has been pointed out that some agricultural communities require ice for only one or two months out of the year, making a permanent ice plant impractical. Formerly ice had to be brought in from distant points at prices as high as $8.00 per ton. Including power, labor, water and depreciation, the new mobile unit can produce ice in these communities at a small fraction of this figure.

Briquettes can be turned out from this unit in any one of four sizes, ranging from 2 ounces to 1.6 pounds each. Automatically ejected from the press, they are spouted out of the car through small openings in the side walls. From there they may be conveyed or shoveled into storage bins or directly to the point of use.

Both briquettes and ice in a snow or crystal form can be produced by the unit. The uncompressed snow is excellent for layer icing of fruit and vegetables because of its fine, soft texture which does not cut or bruise the shipment. The briquettes are ideal for car icing or space

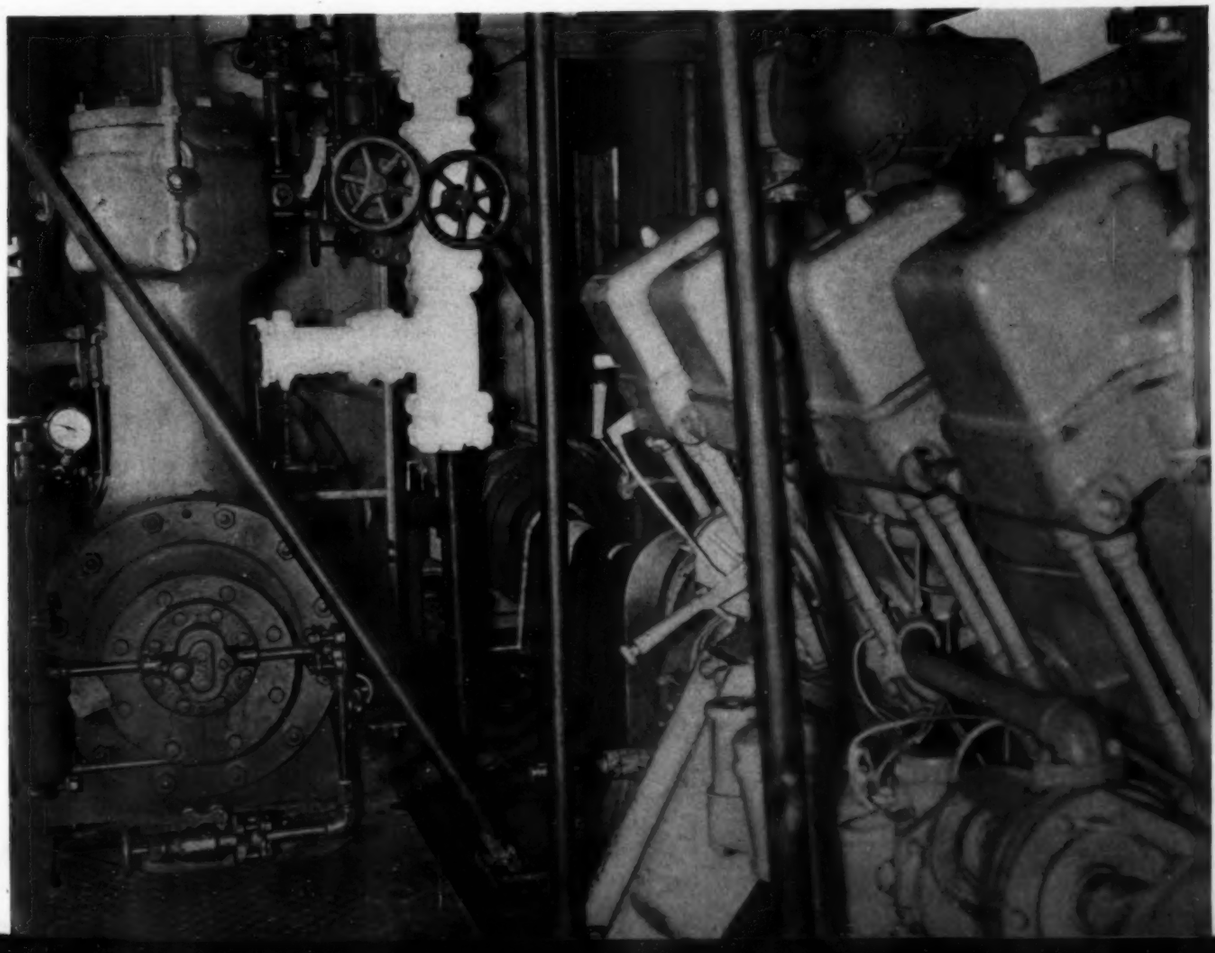
cooling, as their rounded shape is such that ample space is provided for free circulation of air.

The "Caterpillar" Diesel engine operates at 850 rpm., the engine exhaust passing through a water heater and then to a Maxim silencer mounted on the roof. Fuel oil is carried in two tanks fastened underneath the floor of the car, and these tanks have a combined capacity of 435 gallons, sufficient for 80 hours' operation. A twin cylinder gasoline engine of the horizontal opposed piston type is mounted at the rear of the Diesel and is used as a starting engine. The Diesel crankshaft extends beyond the engine block on both ends. One end of the shaft drives a 15 kw. D.C. generator by means of a V-belt connection. Thus all electric power needed for lighting, for pump, fan and other auxiliary motors, and for the automatic control and safety devices, is supplied. The other end of the shaft is connected by means of a frictional clutch to an 8-foot line shaft running slightly above floor level. This drives the ammonia compressor and the Pak-Ice freezer.

A Vilter 8½ inch by 9½ inch single acting, vertical twin cylinder ammonia compressor is V-belt driven from the line shaft as is the freezer which has a capacity of 30 tons of ice in 24 hours.

At the back end of the car there is a reserve water tank sufficient for one hour's operation which is equipped with an automatic switch operating an alarm bell to indicate low water level. At the front end of the car are 16 American air filters of 13,000 cfm. capacity at a velocity of 300 feet per minute. These filters provide air for the evaporative condenser.

A small mountain of ice briquettes discharged for use or trucking to local consumers.
Below: The 160 hp. Caterpillar Diesel and Vilter Pak-Ice machine installed in the box car.



COOPER TEXAS

By ORVILLE ADAMS

Cooper's municipal Diesel plant presents a very neat exterior. Note the Maxim silencers and Marley cooling tower.

THE feasibility and economy of Diesel engines for small municipal plants is amply proved by two years of successful operation of the Cooper, Texas, Municipal Light and Power Plant. Located in this small East Texas city of less than 2,500 population, this Diesel installation is now serving approximately 75 per cent of its citizens and business houses with resultant savings to these subscribers of several thousand dollars a year, according to Dr. J. H. McKinney, the Mayor of Cooper.

A great deal of credit is due Mayor McKinney and his administration for their foresight and patience in dealing with the problem of power cost in their community. The movement culminating in Cooper's Diesel plant began four years ago when careful surveys were made of power requirements and costs. When the complete power rate picture was presented to the citizens there was a general protest because, according to Mayor McKinney, rates in Cooper were materially higher than in surrounding communities. Theoretically, the state law empowers the City of Cooper to regulate utility rates within its corporate limits. Any effort toward exercising this right, however, would have resulted in expensive and protracted litigation so an election was held for the purpose of voting on a municipal Diesel plant bond issue of $100,000.00 to be used in erecting a municipal Diesel plant with amortization and interest to be paid from plant revenue. The contract for the work was awarded to the Central Engineering and Supply Company of Dallas and construction was completed in July, 1935.

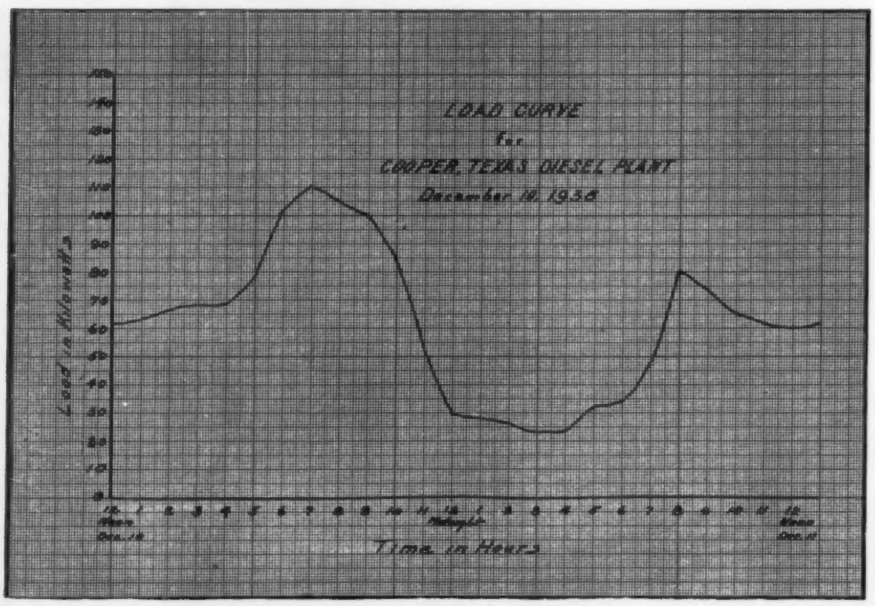
The main equipment consists of two Cooper-Bessemer Diesels, type FP-4, rated at 140 hp. each at 450 rpm., directly connected to 112 kva. General Electric alternators. Control equipment is carried on a G-E dead front, completely enclosed type switchboard. There are two starting-air compressors, one a Cooper-Bessemer combined engine driven unit and the other a Gardner-Denver, motor-driven. Also located in the auxiliary section of the plant are duplicate cooling water circulating pumps, the Goulds Hydroil fuel oil purifier, fuel oil day tank and starting-air tanks.

Adjacent to the brick and concrete building which houses the above equipment are the Maxim silencers, fuel oil storage tank and Marley cooling tower.

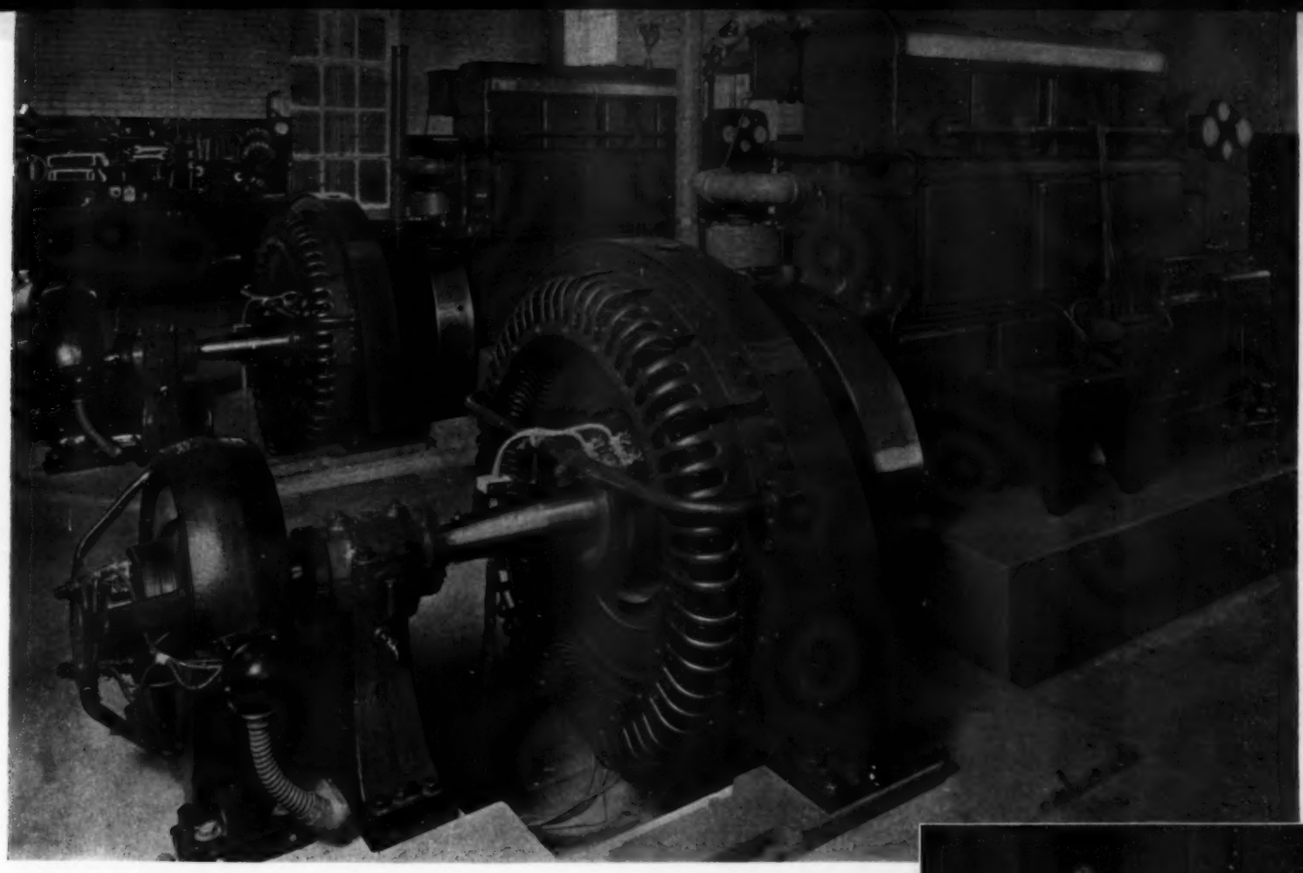
To date, the load has not been sufficient to require paralleling the two generating units so one engine and generator has always been available for standby service. Of course, as the load increases it will be necessary to add a third unit to maintain a proper safety margin. Plenty of space is available for this future expansion.

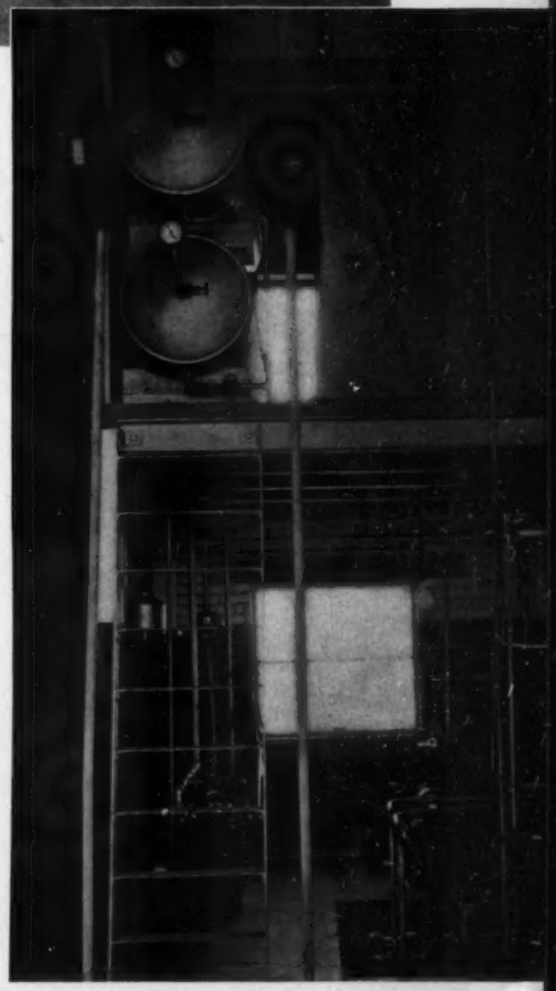
Service from the Diesel plant has been most satisfactory to all subscribers with only one period of twelve minutes' duration when it was necessary to suspend operation. During recent sleet storms when practically all towns in the section were dark for several days due to breakdown of utility transmission lines, the citizens of Cooper enjoyed absolutely uninterrupted service. Such a record for dependability is unassailable.

Upon examination, the financial aspect of Cooper's power set-up is equally satisfactory to all concerned. Prior to the Diesel installation, the city was paying the public utility over $3,000.00 a year for street lighting and water



The daily load curve is typical of this type plant. Multiple Diesel units give maximum efficiency as well as proper standby service.





Two type FP-4 Cooper-Bessemers mean lower electric rates at Cooper, Texas.
Right: In this corner of the engine room are the starting air tanks, compressors and Goulds Hydroil oil purifier.

pumping. Despite the fact that there are now about twice as many street lights as formerly and that they now burn all night instead of a few hours each night, the saving to the lighting department with municipal current at two cents per kwh. is $1,000.00 a year.

Water pumping has likewise increased yet the cost of current for this service, now practically doubled, is one-third less in dollars and cents than when the utility furnished the power for the motor-driven pumps.

Adding revenue from 321 private meters to that from street lighting and pumping brings the total for the plant to approximately $1,500.00 per month. From this gross is deducted fuel and lubricating oil cost, wages for operating personnel and current outlay for distribution extension, meter installations, etc. The net revenue remaining is applied against interest and amortization of the plant bonds. With the cost of electric current at the switchboard less than 1c per kwh., the average cost to the consumer is about 2c, which is materially less than utility power. Further rate reductions may be anticipated when the plant has paid for itself out of earnings and the bonds have been retired. As greater power demand improves the load factor, generating costs will drop correspondingly and make possible still more attractive consumer rates.

LOG SHEET FOR 3 MONTHS

	Kwhs.	*Fuel*	*Lube*
September, 1936 ...	34,000	3,178	33¼
October, 1936	34,600	3,490	24½
November, 1936 ...	40,800	4,000	34½
Total	109,400	10,668	92¼

10¼ kwh. per gal. of fuel
1,189 kwh. per gal. of lube

Fuel cost	$373.38	
Lube cost	38.64	$412.02

Fuel and Oil cost per kwh. 3.68 mills.

Fuel is centrifuged before it is metered and a considerable amount of sludge is therefore deductible from this total fuel consumption. Gas oil is used during the cool months, but in the summer a high pour test distillate at much less cost is used. The fuel and oil cost per kilowatt hour on the switchboard, including labor is less than 1 cent per kwh. Mr. A. D. Hagood, Mr. J. H. Russell and Mr. J. A. Mosely comprise the operating force at Cooper and are to be congratulated upon a fine record of plant service.

Diesel sawmill in the Cascade Mountains, Washington, turning out railroad ties. The power unit uses 22 gallons of fuel per eight-hour day at a cost of five and a half cents per gallon.

THE OLD SAW MILL GOES DIESEL

Two views of the McCormick-Deering unit owned by O. B. Ingram, Lumpkin, Ga. This is a typical second growth timber working job and clearly demonstrates the versatility of the Diesel engine.

WITH the depletion of virgin stands of timber and the resultant shift to smaller sized, second growth cutting and also, due to the fact that these tracts are often quite isolated, the small sawmill is rapidly becoming an increasingly important factor in the nation's lumber industry. In the southern pine region and the northeastern states especially there is a distinct trend away from the larger, more complicated plants to small mills which are usually operated by low cost, internal combustion power plants. Needless to say, the Diesel is a "natural" for this type of service and is finding ready acceptance among logging men with the above mentioned peculiar working conditions.

It is interesting to note how well the various operating characteristics of the modern, lightweight Diesel engine help solve the logging man's present-day problems. In the first place, it is easily moved from stand to stand as the cutting progresses. Since the Diesel requires so much smaller amounts of fuel oil than other internal combustion engines, the time, difficulty and expense of fuel transportation are reduced to a minimum. Likewise, in high altitude regions, there is less power loss from rarified atmosphere due to the inherent operating principle of the Diesel which is not so greatly affected by a decrease in the supply of available oxygen. These points, together with the proven reliability of Diesel units, must of necessity carry enormous weight with a sawmill operator faced with the problem of selecting an efficient and economical prime mover for his mill.

The variety of service and geographical location of Diesels in this business is illustrated by six International Harvester units picked at random. One is owned by the Barker Knapp Lumber Company and works on the western slope of the Cascade Mountains near Hartford, Wash. It produces from 350 to 375 railroad ties per eight-hour day at a fuel cost of one dollar and twenty-one cents. Four are located in Florida running a 48-inch saw, an edger, an 8-inch header strip saw and a planer. Finally, we find the last of the group in Georgia working second growth pine logs into lumber. American Diesels are also finding favor in the logging districts of foreign lands. Duke Ernst von Staremberg, prominent in Austrian political circles, was reported as very enthusiastic with the demonstration of a Caterpillar Diesel tractor pulling stumps to break a logging road and then skidding out timber 60 feet long up a 40 per cent slope. To complete its performance, the American tractor bunched and hoisted the logs onto a cart. Likewise, in the rich mahogany belt of Quintana Roo, Mexico, a similar unit loads eight-wheeled wagons with 2,500 board feet and then pulls them, three at a time, five miles to the Hondo River. These are but a few, but serve to illustrate the almost unlimited field for Diesels in this segment of the logging business.

Clair Elliot of Betula, Pa., is firmly convinced also that Diesels and sawmills make an ideal combination.

"CARMELITE"

Largest All-Welded Diesel Tug from the Bushey Yard

VISITORS at the Battery, New York City, on March 2nd and 3rd last were treated to a preview of this season's most recently completed Diesel tugboat. The density of the crowds attested to the unusual attractiveness of this vessel whose principle dimensions are: 90′ x 22.6′ x 11′ 4″. Although the *Carmelite* is of welded steel construction throughout, her superstructure is painted to simulate wood paneling and gives a very pleasing effect. All crew's quarters are on the weather deck and are finished with genuine wood panels. Each of the four staterooms contains two berths, hot and cold running water, electric lighting and radio outlets, medicine closet, wardrobe and even boasts of curtains on the ports. The captain and mate are similarly accomodated aft of the pilot-house.

The *Carmelite*, similar to all other all-welded Diesel tugs built by Ira S. Bushey and Sons, Inc., is powered by Fairbanks-Morse. Her main engine is a seven-cylinder, two-cycle, solid injection, pump scavenging Diesel rated at 735 hp. at 300 rpm. The 82″ by 48″ manganese-bronze propeller is directly connected through an S.K.F. thrust bearing to the engine which is direct reversing. There are two Fairbanks-Morse 20 hp. auxiliary Diesels, one on the port side driving a 15 kw. generator for lighting and one on the starboard side connected aft to a Northern rotary pump and on its forward end through a Link-Belt drive to a Gardner-Denver air compressor. Exide batteries are provided for starting these two smaller engines. Lubricating oil is handled by a Goulds Hydroil purifier and fuel oil is filtered through units on each engine, a Cuno filter for the main Diesel and Purolators for the auxiliaries. Both air intake and exhaust silencers are Vortex, the latter of the spark arrestor type and opening into the stack. Other auxiliaries include the Smith-Meeker switchboard, the Weil-McLain oil burner and service boiler and American Engineering steering gear. There are two Weston tachometers, one mounted in the pilothouse and the other on the engineer's control panel on the weather deck amidships. This board also carries a Brown exhaust temperature pyrometer. General service electricity is supplied by a 100 cell Edison battery.

Since this vessel will see service on the Great Lakes, both the stack and the pilothouse are demountable to afford ample bridge clearance. In design, construction and equipment, the *Carmelite* is strictly modern in every respect and her builders know from past experience that she will be reliable and economical in operation.

DIESEL ENGINES

By JOHN W. ANDERSON

No. 2 SUPERIOR MODEL "A"

THE Model "A" is built in 2, 4, 6 and 8 cylinders of 4½" bore, 5¾" stroke and is of the four cycle, solid injection, compression ignition or full Diesel type. This engine is manufactured by the Superior Engine Division of The National Supply Company at their Philadelphia plant. The larger sizes of Superior Engines are built in the Springfield, Ohio, plant and are not described in this article.

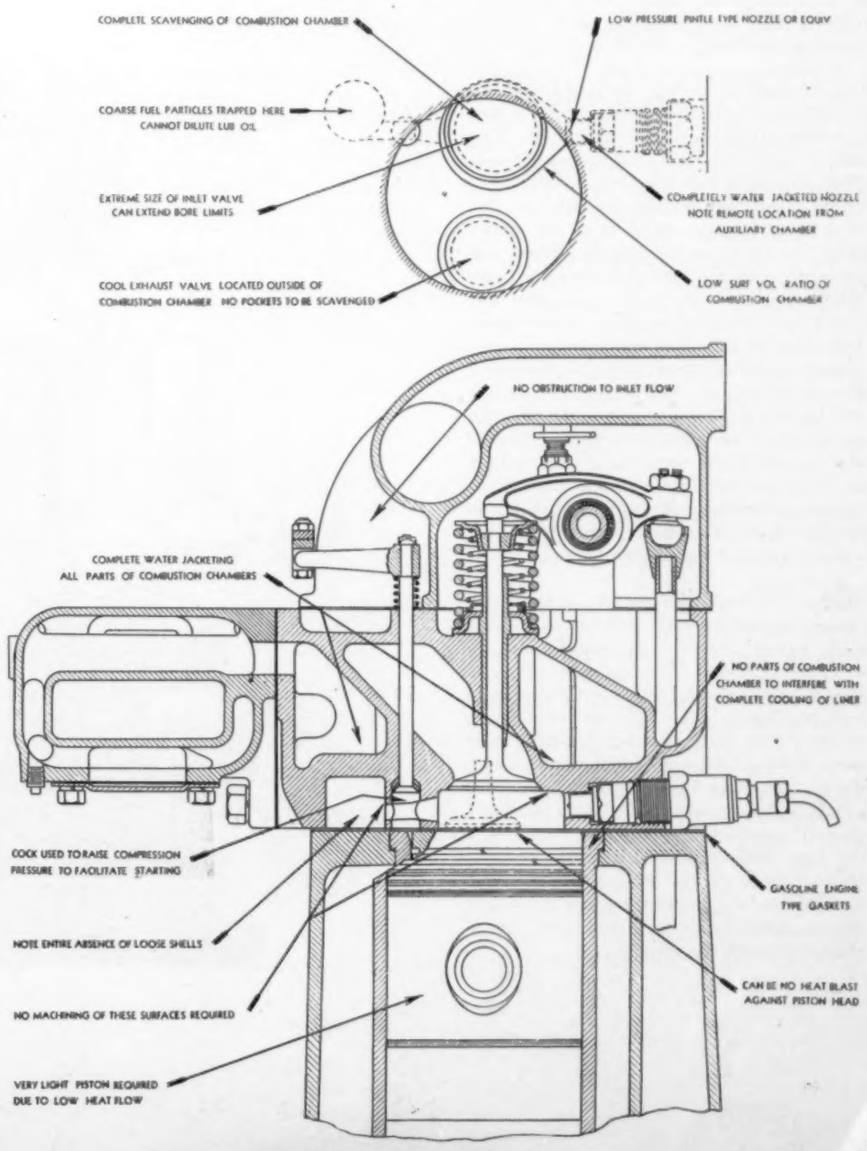
The same general features of design and construction are followed consistently throughout all Model "A" engines. In fact, practically all except the major parts are interchangeable. Therefore, illustrations in this article, while showing one particular model, apply as well to all others in the line. While the Model "A" Superior is referred to as so-called "high speed," still the structure and assembly gives the engine the sturdy, durable features required for heavy types of continuous service.

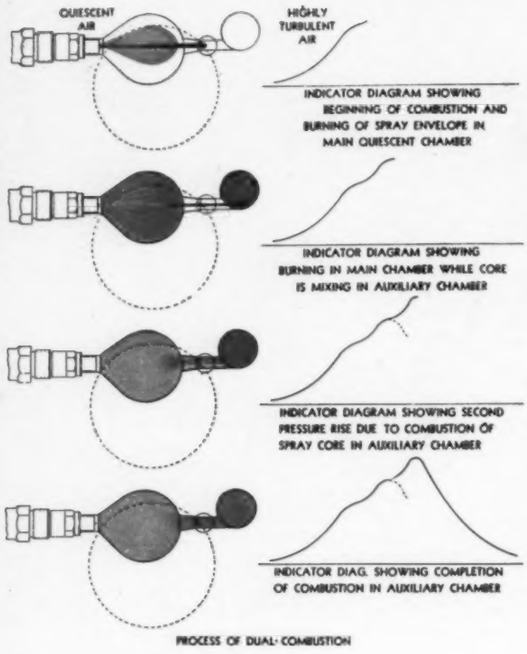
All sizes are offered for marine, power plant, industrial and electric generating sets with power and speed ratings varying according to the service conditions and the number of cylinders.

There are many interesting features of design and construction but perhaps the outstanding and certainly one of the most interesting is the patented Dual Combustion System. The combustion chamber consists of a main and an auxiliary chamber interconnected by a passageway as can be seen clearly in the sectional drawing. The designation Dual Combustion comes from the fact that, while combustion takes place in both chambers, it does so in two progressive stages. The main and auxiliary chambers are cast in the cylinder head and are not machined. They are, however, closely controlled for definite volume. There are no loose parts or inserts and combustion is directed in a manner to avoid excessive heating of the nozzle, piston, valves, or combustion chamber. Both combustion chambers as well as the nozzle are fully water jacketed. It will be seen that the auxiliary chamber is open at the bottom, however, since it is outside the cylinder bore, it becomes a closed chamber except for the passage-way to the main chamber when the head is in place on the gasket.

The inlet valve is located in the top of the main combustion chamber and slightly overlaps the cylinder bore which permits the use of an extra large valve for higher volumetric efficiency and more complete scavenging of the combustion chamber with the cool intake air. The exhaust valve, which has a removable seat, is located outside the combustion chamber and is away from the heat of combustion. Both valves have removable guides.

In the passage-way between the main and the auxiliary chamber is a plug valve that permits closing off the auxiliary chamber from the main chamber. The purpose of this is to increase the compression pressure in the main chamber to assure instantaneous starting in cold weather. The compression ratio when both the main and auxiliary chambers are in use is 11.8:1, resulting in about 360# per square inch compression pressure at cranking speed. When the auxiliary chamber is closed off the compression pressure is about 460# per square inch at cranking speed or about equal to that of an open chamber direct injection engine. The plug valves for all the cylinders are operated by one motion for the entire engine by a sim-


COMPLETE SCAVENGING OF COMBUSTION CHAMBER
LOW PRESSURE PINTLE TYPE NOZZLE OR EQUIV
COARSE FUEL PARTICLES TRAPPED HERE CANNOT DILUTE LUB OIL
EXTREME SIZE OF INLET VALVE CAN EXTEND BORE LIMITS
COMPLETELY WATER JACKETED NOZZLE NOTE REMOTE LOCATION FROM AUXILIARY CHAMBER
COOL EXHAUST VALVE LOCATED OUTSIDE OF COMBUSTION CHAMBER NO POCKETS TO BE SCAVENGED
LOW SURF VOL RATIO OF COMBUSTION CHAMBER
NO OBSTRUCTION TO INLET FLOW
COMPLETE WATER JACKETING ALL PARTS OF COMBUSTION CHAMBERS
NO PARTS OF COMBUSTION CHAMBER TO INTERFERE WITH COMPLETE COOLING OF LINER
COCK USED TO RAISE COMPRESSION PRESSURE TO FACILITATE STARTING
GASOLINE ENGINE TYPE GASKETS
NOTE ENTIRE ABSENCE OF LOOSE SHELLS
CAN BE NO HEAT BLAST AGAINST PISTON HEAD
NO MACHINING OF THESE SURFACES REQUIRED
VERY LIGHT PISTON REQUIRED DUE TO LOW HEAT FLOW


QUIESCENT AIR
HIGHLY TURBULENT AIR
INDICATOR DIAGRAM SHOWING BEGINNING OF COMBUSTION AND BURNING OF SPRAY ENVELOPE IN MAIN QUIESCENT CHAMBER
INDICATOR DIAGRAM SHOWING BURNING IN MAIN CHAMBER WHILE CORE IS MIXING IN AUXILIARY CHAMBER
INDICATOR DIAGRAM SHOWING SECOND PRESSURE RISE DUE TO COMBUSTION OF SPRAY CORE IN AUXILIARY CHAMBER
INDICATOR DIAG. SHOWING COMPLETION OF COMBUSTION IN AUXILIARY CHAMBER
PROCESS OF DUAL COMBUSTION

But by this time, the fuel in the secondary chamber has begun to burn, and the flow of gas in the connecting passage-way reverses. There is a secondary rise of pressure in the main chamber as shown on the indicator diagram at the right of the third picture. Finally, as in the last picture, the combustion is complete and the maximum pressure in the cylinder reaches from 450 to 540 pounds. The time interval between the combustions in the main and auxiliary chambers is clearly shown on the indicator cards.

There are many advantages claimed for this system. The combustion is progressive and proceeds smoothly, thus the rate of pressure rise is relatively low for each degree of crank travel. This system has the advantages of the open chamber where high compression for quick starting is retained plus the advantages of the low compression for reducing peak pressures when the passage-way between the two combustion chambers is open for normal operation. These engines are relatively insensitive to fuel specifications and to exact timing of the fuel injection pump.

Under test, this engine has shown a brake mean effective pressure of 124 pounds per square inch but in service 90 pounds is the top rating and 75 pounds is usual for continuous duty. These engines have been operated as high as 2200 rpm. and will idle down to 300 rpm., thus the service ratings provide a good margin under test stand performance. At 90 bmep., 1400 rpm. fuel consumption is less than .42# per bhp. per hour. The fuel curve is relatively flat from 1000 to 2000 rpm. – tests showing a variation of less than 5 per cent at 90 bmep. The published ratings for the different models in this line are:

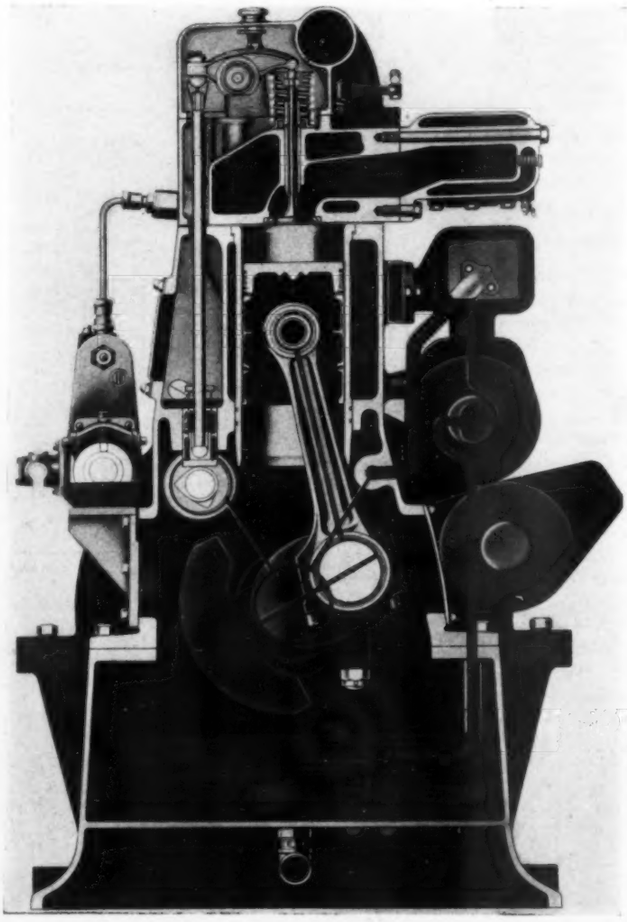
Engine Size	Stationary Speed	Service Horsepower	Marine Speed	Service Horsepower
2 Cyl.	1200	21	1400	28.8
4 Cyl.	1400	48	1500	62.2
6 Cyl.	1400	74	1600	100.2
8 Cyl.	1400	97	1800	150.0

The crankcase and cylinder block are cast in one piece. It is the structural backbone of the engine. Separate replaceable wet cylinder liners are used. The cylinder heads are cast in pairs and are bolted to the top of the cylinder block with a flat copper-asbestos gasket,

ple lever and linkage arrangement that is controlled at the engine or can be easily arranged for remote control.

The injection nozzle lies horizontally as can be seen in the sectional drawing and the fuel is sprayed across the top of the piston. The nozzle is of the pintle type and is operated at 1600# per square inch operating pressure. The maximum injection pressure through the operating range of this engine does not exceed 1850# per square inch. The spray from this pintle type nozzle is conical in shape and consists of a rather coarse partially atomized core with a finely atomized envelope of fuel spray. The shape of the main combustion chamber is made to suit the shape, as far as possible, of the envelope of the fuel spray. This is best seen in the plan view at the top of the diagram. The core of the fuel spray is directed into the passage-way between the main and the auxiliary chambers. Since the fine spray is first ignited combustion takes place in the main chamber first. The coarse spray enters the auxiliary chamber and is then ignited.

The top picture in the diagram shows the beginning of fuel injection with the spray core going straight through the passage into the secondary chamber. This portion of the spray consists of the heavier particles which have a high penetrating power, but do not burn as quickly as the finely atomized particles in the spray envelope. As the second picture shows, the spray envelope fills the main chamber completely, and the heat quickly ignites the finely atomized particles. As they burn, there is a rise from 380# compression pressure to about 450#. This provides further turbulence and considerable heat for the secondary chamber as the hot gases flow into that chamber in an effort to equalize the pressure.

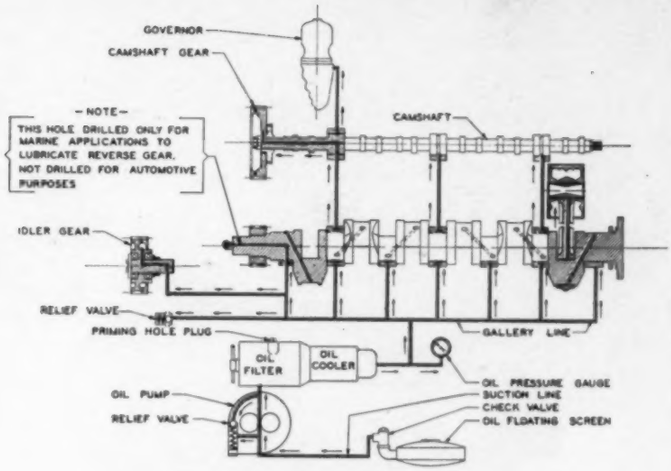


which seals the gas and water joints. The heads carry all of the valves which seat directly in the heads without cages, and the exhaust valves have removable seats. The valves are operated by rocker arms and oil cushioned tappets and push rods. Removable covers on top of the cylinder heads enclose the valve gear, and provide passages for the air from the intake silencers to the intake ports. The camshaft is in the upper part of the crankcase at one side, and has the cams forged integrally with the shaft. It is carried in ball bearings at each end with plain bronze bearings in between, and is driven from the crankshaft by gears.

The crankshaft on all models is a steel forging provided with counter weights in order to give a good balance for the engine and reduce the internal unbalanced loads to a minimum. The main bearings are secured to the under side of the crankcase structure. The crank pin and main bearings are of the precision type with steel backs and cadmium nickel linings. They are without adjustment, and new bearing shells are installed when necessary without scraping or fitting. Wrist pin bearings are the full floating type.

Cast iron pistons are used in all engines up to speeds of 1600 rpm. Aluminum pistons are used at higher speeds.

The lubrication system is the full pressure feed type. A gear type pump is driven from the crankshaft and takes its suction from the sump through a floating screen. Oil is delivered under pressure through a filter and cooler to the distributing line which is drilled in the crankcase casting. Crankshaft and connecting rods are drilled, in fact, all of the oil passages



LUBRICATING OIL CIRCULATING SYSTEM

throughout the engine are drilled and no piping is used. The engine is fully enclosed and all parts are lubricated from the one system, either directly by pressure or by oil mist, according to their individual requirements. Surplus oil drains back to the sump. The illustration shows the complete lubrication system.

Cooling water flows first through the oil cooler and then into a distributing manifold, from which it is directed around each cylinder. The flow is then upward around the cylinder liners into the cylinder head and around the valve seats, combustion chambers and nozzles and from there into the outlet header or through the water jacket exhaust manifold, when used. A thermostatically controlled bypass sends as much water back to the suction as is necessary to maintain the proper water outlet temperature. Circulating water pumps are built into the engine but vary in type according to the service. Centrifugal pumps are used with radiators and other closed cooling systems and a gear pump where positive suction is required. The gear pump is driven by separate gears to avoid the grinding action and wear which would result from the use of dirty cooling water.

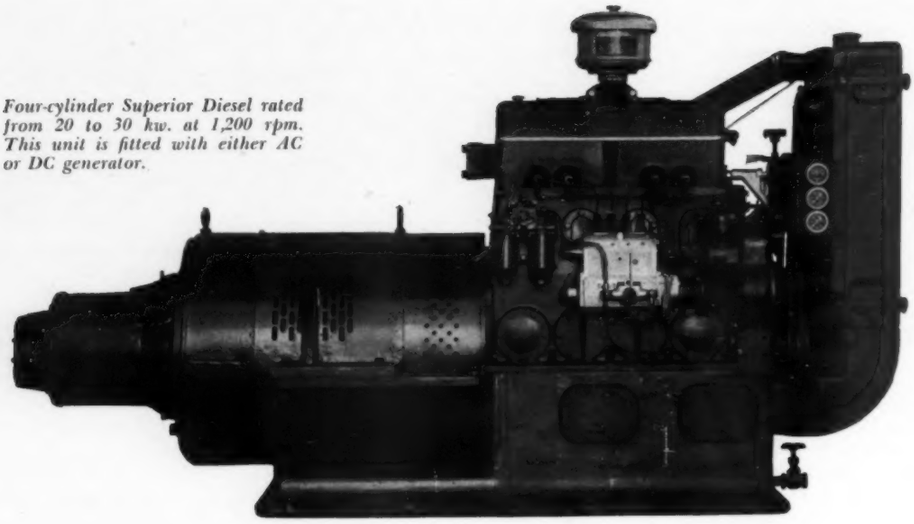
The lubricating oil pump, cooling water pump, lubricating oil filter and cooler are built as a complete assembly and located on the outside of the engine for convenience. The lubricating oil pump has a pressure adjustment. Timing gears are of the helical tooth type with 2" width face. The idler gear is supported by a shaft running in ball bearings.

Engines in this line are electrically started and are also equipped with a voltage regulated type of generator for recharging the starting batteries.

The fuel oil filter, air intake filter and silencer, unit fuel injection pump and gauge panel with lubricating oil pressure, cooling water temperature, and ammeter dials are all located on the engine. The speed is controlled by the governor which is built in at the gear end near the injection pump. It is pressure lubricated and is arranged to control the engine speed at any desired setting from idle to full speed.

Another distinctive feature of this engine is its unit control lever which is mounted at the timing gear end and moves through an arc of about 160 degrees. The starting motor switch is located in the control lever handle. The movement of this lever in one direction rotates a lay shaft contacting a lip on the inlet valve push rod guide cups, raising the valve, thereby releasing compression to permit free turning of the engine. This is beneficial in cold weather as it permits high cranking speed prior to starting. The movement of this lever in the opposite direction permits the inlet valve to function normally and fuel is injected for starting. Additional movement of the lever gives throttle or speed control, maintaining the engine under

Six-cylinder Superior, with radiator attached, for stationary duty.



Four-cylinder Superior Diesel rated from 20 to 30 kw. at 1,200 rpm. This unit is fitted with either AC or DC generator.

governor regulation. When the engine is running the starting motor button can not be engaged.

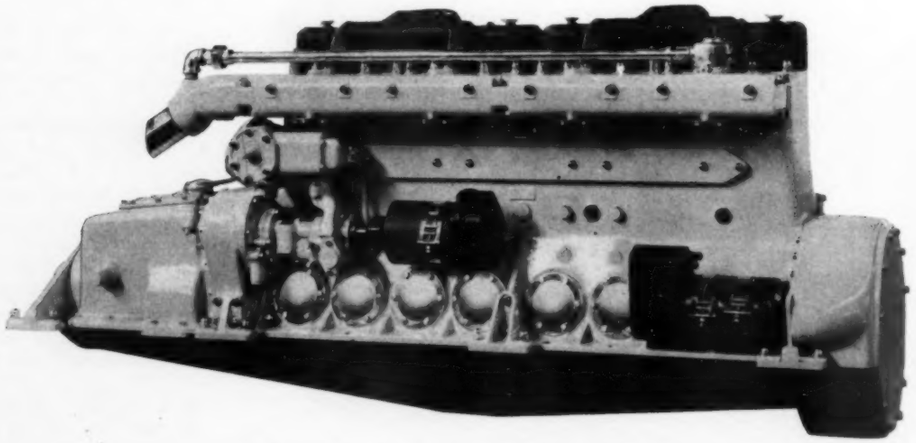
All models have hand hole plates in the side of the crankcase for access to the bearings and other internal parts. In addition to these hand holes in the crankcase, the stationary and generating unit applications have large inspection plates in the lower base casting.

The four, six and eight cylinder marine engines are offered in true right and left hand construction for twin installations. Marine engines are provided with an extended length of oil pan as a support for the reverse gear. Both the reverse and the reduction gears are pressure lubricated from the main oiling system in the engine, the oil being carried to the reverse gear through a drilling in the crankshaft and from the reverse gear to the reduction gear, when used, by means of a drilled reduction gear shaft. The reduction gears are water jacketed, the cold water being drawn through the gear from the suction side of the pump before it reaches the engine.

Provision is made for ventilating the crankcase by a drilled hole connecting the intake passage in the cylinder head with the valve chamber. This not only draws off the crankcase fumes but also causes lubricating oil mist to rise to the valve chamber where it is condensed on the rocker arms and valve gear assisting in lubricating the guides and other moving parts. Electric generator units are of the close coupled construction using a single bearing generator supported on an extension of the engine base. On alternating current generators, the exciter is directly connected and overhangs the generator. Industrial and stationary types are arranged according to the requirements of the application having clutches for belt drive, stub shafts, built-in reduction gears, radiators, sheet metal housing and similar equipment. The industrial and stationary engines are mounted on a cast iron base and where clutches are used, they are of the lubricated type.

Where complete vibration elimination is a necessity vibration dampers are available. Where complete sound proofing is required suitable acoustical housing for various engines and assemblies have been developed. These have been designed for easy accessibility of control and inspection of assemblies.

The accompanying photographs illustrate representative models of the Superior Model "A" line as offered for marine, generating set and stationary types of service.



Eight-cylinder model for marine propulsion with Joe's reverse gears mounted integrally with the engine.

Motor liner "Dunnottar Castle" of the Union Castle fleet; 15,000 tons gross and 9,500 hp.

LONDON LETTER NO. 17

By GEORGE LIND

IN the March contribution to this series the position of the small Diesel-engined vessel was reviewed. From the facts and figures presented it was abundantly apparent that this type of ship is rapidly ousting its steam-propelled contemporary. What then of the larger classes of vessel – passenger liners, cargo boats and tankers?

Last month a quotation from an eminent marine writer was given, and it is now proposed to draw on a similar account, this time from a well-known book of reference, namely, the British Motor Ship Year Book for 1937.

"For the first time since 1931 the Diesel-engined tonnage placed in operation during one year has exceeded 1,000,000 gross. In fact, as regards the tonnage output and the figures for indicated horse-power of machinery installed, 1936 was more or less a repetition of 1931, with a slight balance in favor of last year's engine figures, which were practically 850,000 ihp. Omitting all consideration of vessels with a tonnage not exceeding 1,000 gross, there were close on 170 motor ships placed in commission in 1936, ranging from the new types of large coastal and short-service vessel (the construction of which in their present numbers is almost, if not wholly, due to the application of Diesel propulsion) to the fastest class of motor passenger liner. Further, and what is equally important, there were in December, 1936, orders in hand representing about 1,750,000 tons gross of large motor ships, numbering 350 in all.

The position with reference to laid-up tonnage is not unsatisfactory, for although the figures in the appropriate table still show a substantial amount, *i. e.* 3¾ million tons, *the bulk of it represents American shipping.* The residue is unimportant, for it comprises ships of so old and inefficient a nature that their further employment will have no real influence on shipping in the ordinary course of events.

Tonnage Laid Up at Various Periods

	Gross Tons
January 1, 1933	14,600,000
January 1, 1934	10,700,000
January 1, 1935	6,500,000
January 1, 1936	4,800,000
January 1, 1937	3,750,000

So far as the relative standing of motor ships and steamers is concerned, the proportion of the former now building remains practically the same as last year in January, *i. e.* approximately 70 per cent. in tonnage. The output of motor ships and Diesel machinery in 1936 is shown in the table below, together with the figures for the previous eight years.

Motor Ships and Engines Completed

Year	*Gross Tons*	*Machinery ihp.*
1928	1,177,235	796,910
1929	1,130,475	914,250
1930	1,640,290	1,307,550
1931	1,184,560	845,400
1932	358,990	266,950
1933	364,930	323,350
1934	483,730	480,300
1935	782,360	622,380
1936	1,075,480	848,860

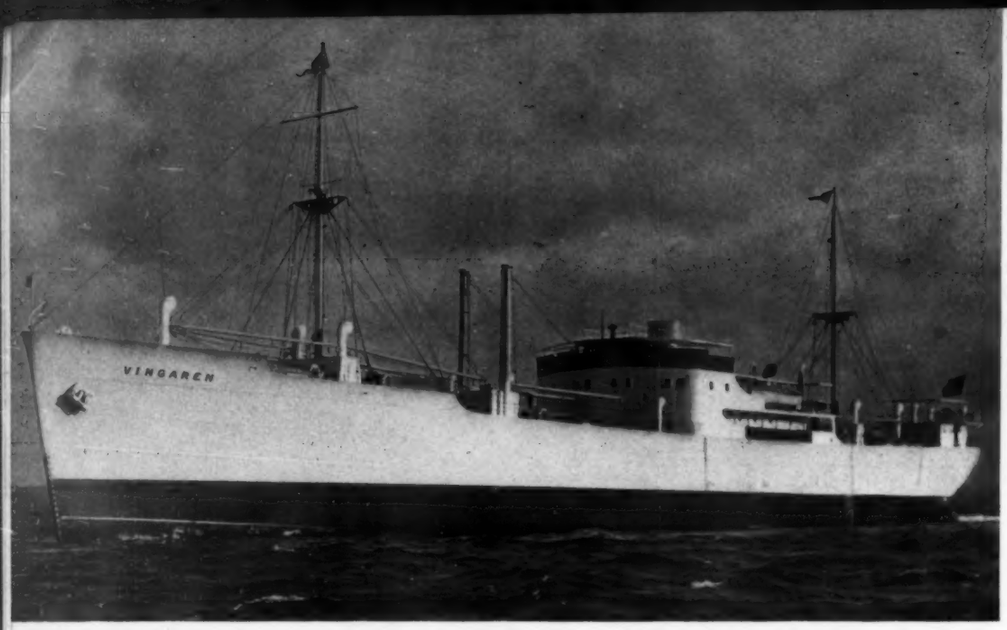
The progressive increase in the tonnage of motor ships on order is shown in the following table:

Motor Ships on Order

Date	*No.*	*Gross Tonnage*
January 1, 1933	82	460,000
January 1, 1934	103	592,000
January 1, 1935	131	816,000
January 1, 1936	226	1,325,000
January 1, 1937	350	1,750,000

The above figures show beyond all question the immense progress made by the motorship at the expense of the steamer, and if final proof is required, it is only necessary to mention that for the years ending July, 1935 and July, 1936, the gross steamer tonnage afloat showed a one per cent decrease as compared to a nine per cent increase for motorshipping.

Diesel tanker "British Destiny," with a "bone in her teeth." Powered by a Harland & Wolff 2,850 hp. engine.



The Eriksberg-built cargo motorship "Vingaren" fitted with two B & W Diesels totalling 5,100 hp.

Before turning to the usual descriptions of recently completed vessels, there is one item of news of historic importance, which must be included here. It concerns the celebrations of 25 years of service by the world's first large ocean-going motorship, the *Selandia*. This redoubtable old veteran has now covered over 1,200,000 miles, and, under the name of *Norseman*, is still giving regular and trouble-free service on Atlantic and Pacific routes.

The *Selandia* was built by Burmeister and Wain in Copenhagen for the East Asiatic Co., and is powered with two four-stroke single-acting engines developing 1,250 ihp. each at 140 rpm. She has a length of 370-ft. 5-in., a deadweight capacity of 7,600 tons, and a service speed of between 10½ and 11 knots at sea. On her maiden voyage from Copenhagen she sailed out to Bangkok, via the Suez Canal, a run of 980 hours, without a single engine part being removed or overhauled. Then, after a few minor adjustments, she returned to Copenhagen, to be welcomed by thousands of cheering spectators on her arrival. Since then she has maintained her regular schedule of sailings, and, today, is still averaging a steady 10½ to 11 knots. At the time of her sale and renaming, the buyers' inspecting engineer made a report on the ship's condition, and besides remarking that it was unnecessary to do anything at all with her in the way of modifications, made the observation that in his opinion the engines would outlast the hull in so sound a condition were they!

So much for the stalwart old *Selandia*. Here then by contrast is a description of one of Harland and Wolff's latest productions, the twin screw passenger and cargo motorship *Dunnottar Castle* built for the Union-Castle Line's service to South and East Africa.

The *Dunnottar Castle* is a fine addition to the long list of vessels constructed for the Union Castle Line by Harland & Wolff, during the last half century, and has been followed recently by a sister vessel – the *Dunvegan Castle*. The *Stirling Castle* (25,550 tons) and the *Athlone Castle* (25,564 tons) sailed from Southampton on their maiden voyages with the weekly mails for South Africa in February and May last respectively, so that during the last twelve months the Union-Castle Line will have placed in service four new passenger and cargo vessels, with a total tonnage of 80,000 tons.

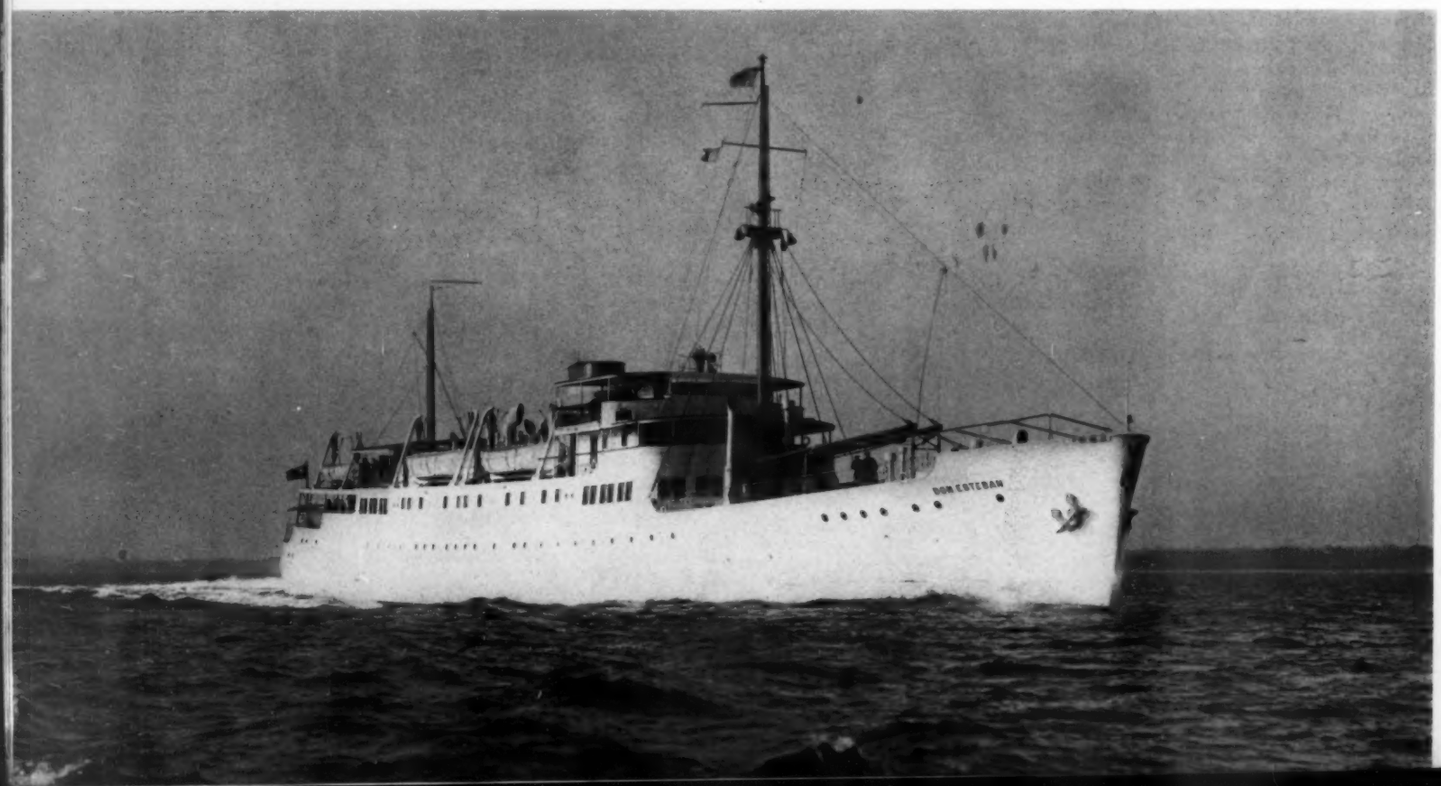
As already mentioned the *Dunnottar Castle* is a twin screw motor vessel, and the principal dimensions are as follows:

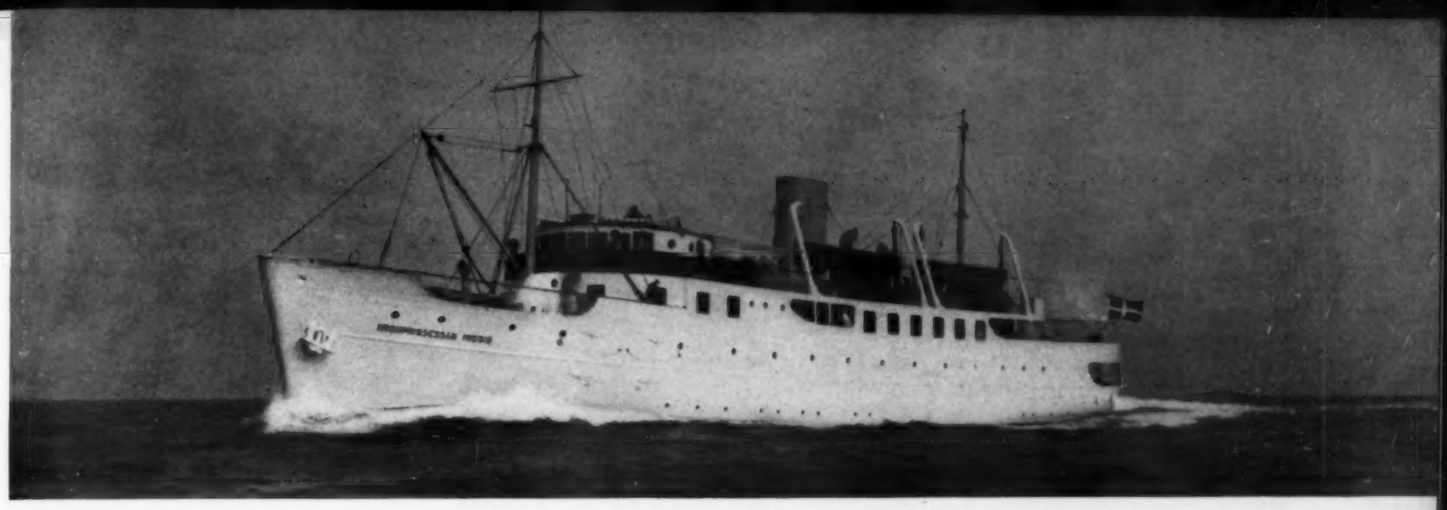
Length overall	about 560'0"
Length B.P.	530'0"
Breadth moulded	71'6"
Depth moulded	35'0"
Gross tonnage	15,007
No. of holds	5
Passenger accommodation 1st class	258
Passenger accommodation tourist ..	250
Propelling machinery output ..	9,500 bhp.
Engine speed	110 rpm.
Electricity supply	1,400 kw.

As will be seen from the accompanying illustrations, the vessel has a really graceful and well-balanced appearance – a feature common to all these new Union Castle ships. She has a well-raked rounded stem and a cruiser stern, two masts and a single low streamlined funnel.

The twin main engines of this vessel are of a type which has been installed in over fifty passenger ships and cargo vessels. They are of the well-known Harland-B. & W. double-acting, 2-cycle airless injection type, each having 9 cylinders 450 mm. bore x 1200 mm. stroke. The design embodies the uniflow scavenge system and the tuned exhaust pipes principle.

1,750 hp. Diesel passenger liner, "Don Esteban."





Two 1,100 hp. Polar Diesels drive the Swedish ferry, "Kronprinsessan Ingrid."

In accordance with the uniflow principle, scavenge air is admitted to the cylinders through ports arranged around the complete circumference of the liner, and uncovered by the piston, the tangential arrangement of these ports giving swirling motion to the scavenge air and affording the necessary turbulence for good combustion. The exhaust is released by piston valves arranged in the top and bottom cylinder covers. With this arrangement of scavenging the temperature gradient is uniform and the heat stresses in the cylinder liners are considerably reduced, whilst high mean pressures with smokeless combustion are attained.

The electric supply is taken from four 350 kw. generators driven by Diesel engines of the Harland-B. & W. 2-cycle, single-acting poppet valve uniflow type, each having six cylinders 280 mm. bore x 500 mm. stroke and running at 330 rpm.

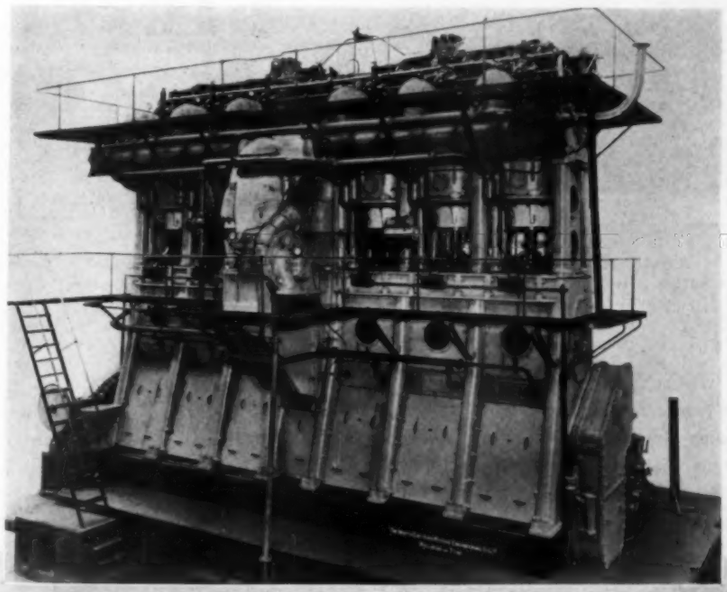
Another interesting vessel just completed at Harland & Wolff's yards is the *British Destiny*, the second of six motor driven oil tankers ordered by the Anglo Persian Oil Company through their subsidiary, the British Tanker Co.

The *British Destiny* which has just completed very satisfactory trials is a single screw motor driven oil tanker, designed to meet Lloyd's latest requirements for the carriage of petroleum in bulk. The vessel is built on the longitudinal and transverse system of framing and the hull is divided by transverse bulkheads into twenty-seven oil carrying compartments. Provision has been made for the carriage of oil fuel forward of the motor room in a deep tank and under the motor room in a double bottom tank.

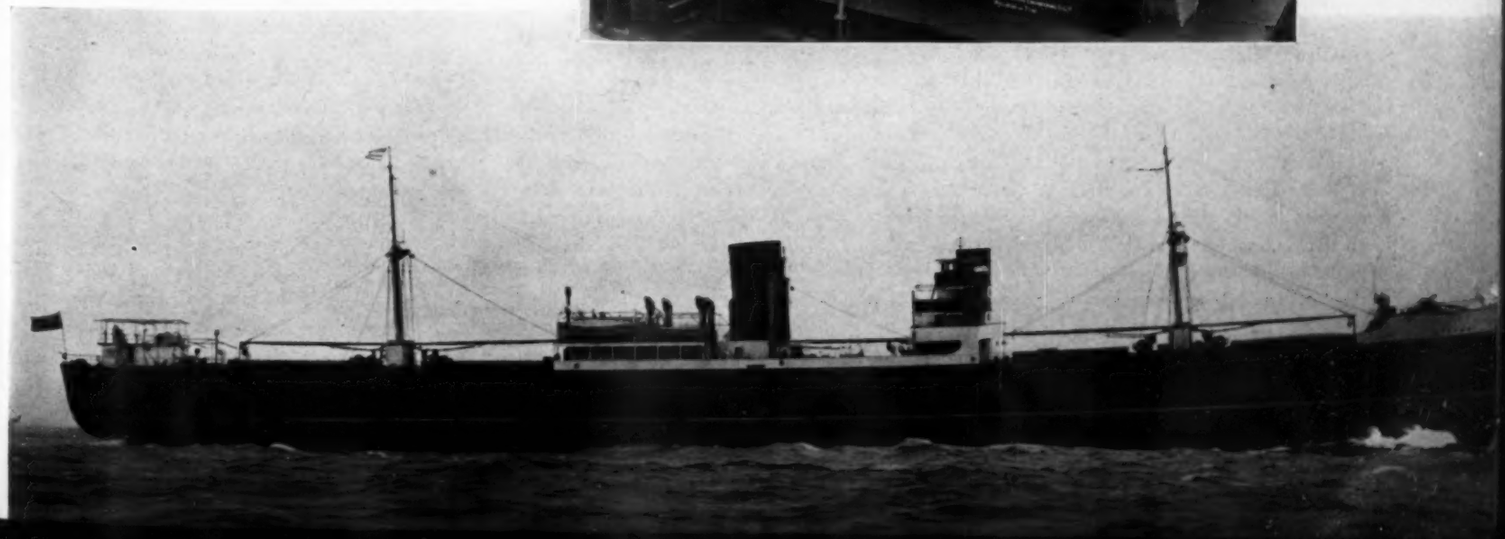
The propelling machinery, also constructed by Harland & Wolff, Ltd., consists of a six cylinder four-stroke Diesel of the single-acting, crosshead type with airless injection and under-piston pressure induction. It has a bore and stroke of 200 and 1500 mm. respectively and develops 2,850 bhp. at 105 rpm.

The three smaller motorships, of which illustrations are given here, were all built on the Continent. The *Vingaren* is a product of the famous Eriksberg yard, and is owned by the Raderiaktielbalaget Transatlantic, Gothenburg. She is of the modern shelter-deck type with long low forecastle, and has been built to the highest class of Lloyd's Register, with strengthening against ice. She has two continuous decks, and one 'tweendeck forward. The deadweight capacity is 6,135 tons on a draught of 23 ft. 9½ in., and the service speed is 14½ knots.

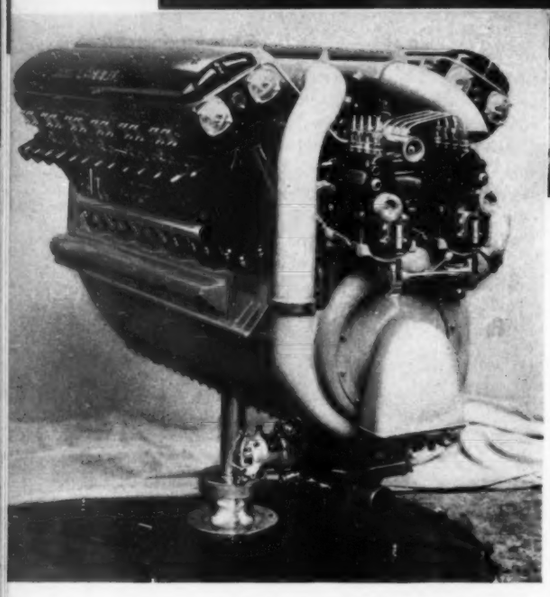
. . . . *And now please turn to page 64*



Trial run of the North-Eastern Marine motorship "Hylton." The 2,500 hp. Diesel appears above.



At the Paris Aviation Show, November, 1936. M. Lebrun, the President of France, congratulates M. Coatalen on his new engine at his stand at the Show.



Three-quarter rear view of the Coatalen "12 Vrs 2" Diesel, showing the fuel pumps and gear-driven centrifugal supercharger. Below the latter are the water pump and the two fuel transfer pumps.

DIESEL AIRCRAFT ACTIVITIES

By PAUL H. WILKINSON

THE recent appearance of the Coatalen Diesel in France is a reminder that the subject is very much alive in that country. For several years, Louis Coatalen has been an ardent advocate of this type of engine for aircraft, and the excellent design of his latest product certainly does him credit.

Coatalen's early experience in the internal combustion engine field was obtained in England. From 1900 to 1907 he was with the Humber Motor Car Co., Ltd., at Coventry, leaving them to join the Sunbeam Motor Car Co., Ltd., at Wolverhampton. As chief engineer of the latter firm, he did a great deal of design work on the Sunbeam gasoline aircraft engines such as the 100 hp. *Dyak*, the 300 hp. *Manitou* and the 1,000 hp. *Sikh* of post-war vintage.

In 1926, he became interested in the possibilities of the Diesel and converted a small two-cylinder Benz to work on this principle. By 1929 he had designed and supervised the construction of his first aircraft Diesel which was exhibited at the Aviation Show in London that year. Known as the Sunbeam-Coatalen *P-1*, this six-cylinder, water-cooled engine was rated at 104 hp. and was a very neat looking job.

Leaving the Sunbeam firm in 1931, Coatalen returned to France and continued his research, this time on a six-cylinder Panhard which he rebuilt to suit his purpose. After successfully developing several new ideas, particularly with reference to mechanical fuel injection, he brought out his new engine, the Coatalen *12 Vrs 2*, in time for the Aviation Show in Paris in November, 1936. There his engine received much favorable comment.

The Coatalen *12 Vrs 2* is of orthodox twelve-cylinder, water-cooled design, built for rugged service rather than minimum weight. It has a bore and stroke of 5.91 in. and 6.69 in. respectively, and a displacement of 2,199 cu. in. It is rated at 550 hp. at 2,000 rpm. at 10,000 ft., and its weight is 1,170 lbs., which works out at 2.12 lbs. per hp. While this is on the heavy side, the weight ratio can doubtless be considerably reduced by increasing the power output.

On the block test, the new four-cycle Diesel developed 600 hp. at 2,200 rpm. and had a fuel consumption of 0.36 lbs. per hp. per hour.

It is confidently expected that this can be reduced to 0.33 lbs. in the very near future. Fuel injection is by means of two multiple unit pumps working at a pressure of 9,954 lbs. per sq. in. There are two inlet and two exhaust valves in each cylinder head. In accordance with modern practice, the engine is equipped with a gear-driven supercharger.

Diesel activity in the air in France last year, however, was not as much as might have been expected. A prize of 10,000,000 francs, equivalent to approximately $450,000 at the present rate of exchange, went begging for want of action on the part of the manufacturers. This was the award offered by the French government for the first Diesel-engined plane equipped with a French engine to break the non-stop speed record for 10,000 kilometers, or 6,200 miles, before the end of 1936. At present the record is held by a gasoline-engined plane which covered the distance in 1931 at a speed of 93 mph.

Presumably it was hoped to stimulate Diesel activity in France, for at least one plane, the Bernard *82*, was built for an attempt at the record. Powered with a C.L.M. *Lille 6 A.S.* engine of 550 hp. built under Junkers license, the Barnard *82* should have been able to win the prize, or at least the 5,000,000 francs to be awarded for an engine built under foreign license. With a load of 12,300 lbs. of Diesel fuel, a cruising range of 7,300 miles is anticipated under favorable conditions at a cruising speed of 124 mph. It remains to be seen whether the opportunity will be offered again this year now that the Coatalen Diesel of French design is available.

The latest news from the United States comes from Texas, and is to the effect that the new Guiberson *A-1020* Diesel will shortly undergo its A.T.C. tests and be made available for the commercial market. This nine-cylinder, radial, air-cooled engine is slightly larger than the *A-918 M* model inasmuch as it has a bore and stroke of 5.125 in. and 5.50 in. respectively, with a displacement of 1,021 cu. in. Operating on the four-cycle principle at a B.M.E.P. of 103 lbs. per sq. in., it is rated at 320 hp. at 2,200 rpm. and weighs 620 lbs., or 1.94 lbs. per hp.

The valve arrangement of the *A-1020* consists of one inlet and one exhaust valve in the cylinder head. Injection is by individual pumps operating at a pressure of 2,200 lbs. per sq. in., and the fuel consumption is said to be 0.34 lbs. per hp. per hour. For starting purposes, an Eclipse electric inertia starter or a Coffman cartridge starter can be used. Equipped with a supercharger, the new engine is expected to have a power output of 440 to 500 hp.

Australian aircraft transport companies are looking forward with considerable interest to the arrival of a Diesel-engined Junkers *Ju 86* ten-passenger airliner which will soon be put into service there. The plane, which is equipped with two Junkers *Jumo 205* engines, bears the name of the well-known Australian pioneer, *Lawrence Hargrave*. Large operating economies are anticipated on account of the low fuel consumption and the cheap price of fuel oil which are essential for profitable operation over the large, sparsely populated continent.

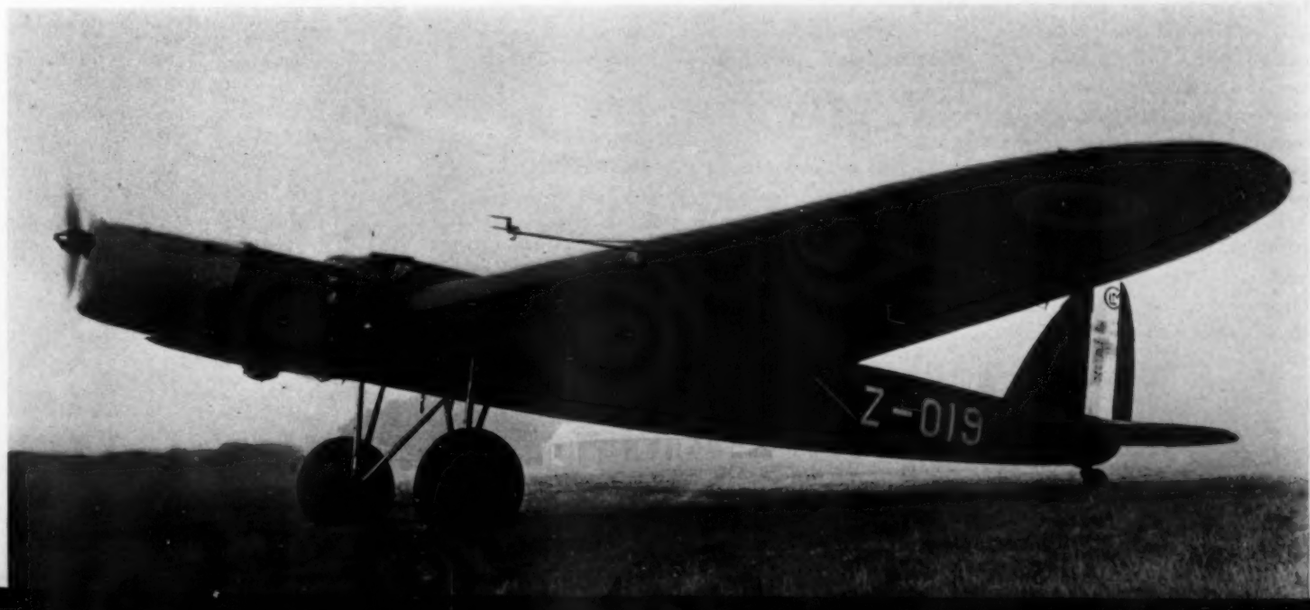
The *Ju 86* took off from the factory at Dessau on February 17 for Melbourne. The flight of 13,700 miles was routed by way of Rome, Tripoli, Cairo, Bagdad, Karachi, Calcutta, Singapore, Darwin and Sydney to give the inhabitants of these flourishing communities an opportunity to see the new type of engine. The crew of three consisted of Dipl. Ing. Engelbert, who is in charge of the expedition; flight captain Kommel, who has over 600,000 miles of flying to his credit; and radio operator Reinhardt.

Crew of the Junkers "Ju 86 Lawrence Hargrave," now on its way to Melbourne to demonstrate the advantages of the Diesel to the Australian airlines.

Zeppelin activity is beginning to take shape for the coming season, and the *Hindenburg* is being prepared for another series of flights to the United States. The schedule for 1937 calls for eighteen round-trip flights between Frankfurt and Lakehurst, commencing on May 3.

The *LZ-130*, now under construction, is due to be completed this Fall and will be followed by the *LZ-131* and *LZ-132*. When this fleet is ready in 1940, regular service will be possible between Germany and the United States, South America, the Dutch East Indies and India.

The Bernard 82 long-range monoplane equipped with a 550 hp. C.L.M "Lille 6 A.S." Diesel built under Junkers license. With a fuel load of 12,300 lbs., it has a cruising range of 7,300 miles.



CHICAGO DIESEL FIRE BOAT

CHICAGO'S new Diesel fire boat, the *Fred A. Busse,* is the largest of her type in the world; 1,250 hp., comprising five Cummins Diesels of 250 hp. each at 1,000 rpm., is the power available for propulsion and water pumping. In addition, there is a 30 kw. Cummins Diesel generating set and a 5 kw. Hill balanced Diesel emergency generating unit. All of the above engines and generators plus four Dean-Hill 1,900 gpm. centrifugal, diffuser type pumps are installed in an electric welded, all steel hull, measuring 90′-6″ by 22′-4″ by 11′-0″. Except for the galley space forward, the entire hull below the main deck is, similar to submarine construction, filled with machinery as indicated by the inboard profile and plans on the opposite page.

Of the five main Cummins Diesels, the two forward can be used for pumping only and are directly connected to their respective pumps through flexible couplings. The center Diesel, aft, is used for propulsion only and will handle most of the maneuvering. It drives a 42″ by 26″ Columbian propeller through a planetary reverse gear and a reduction gear with a 1.64 to 1 ratio. Direct handling of this unit from the pilot house is possible through Kimball controls. The two wing engines aft are arranged for double service of either propulsion or pumping. At their forward ends they are connected to their pumps through flexible couplings and Twin-Disc clutches and at the after ends to 30″ by 24″ Columbian propellers through planetary reverse gears with no reduction.

Naturally, the most important feature of any fire boat is its ability to throw water, i.e., its pumping capacity and the effectiveness of its deck equipment in directing the streams. The pumping capacity of this vessel was specified to be 7,500 gpm. at 150 pounds pressure and half that amount, or 3,750 gpm., at 300 pounds pressure. The results of builder's tests conducted by The Defoe Boat and Motor Works, Bay City, Michigan, were as follows: At 150 pounds pressure over a four-hour period, 9,040 gpm. were delivered, which is 20 per cent over specifications. At 300 pounds pressure over a period of two hours, 4,370 gpm. were pumped, which is 16 per cent above requirements. In order to give our readers some more tangible idea of just what these figures mean in everyday fire fighting, it should be pointed out that at 150 pound pressure during the four-hour test this boat was throwing more than a tank car load of water per minute.

Distribution of this water is accomplished by means of three deck monitor turrets and one monitor on the tower, supplemented by two batteries of six each 2½″ hose valves, one on each side of the deckhouse. This affords maximum distribution efficiency in placing water at the scene of a fire either direct from the deck or tower, through the monitor turrets or through hose lines carried ashore. With the two pumps on either side connected in series, and so discharging at 300 pounds pressure, a

stream of water can be thrown directly from the deck of the ship a distance of 300 feet and with a battering force of 2,700 pounds, which is sufficient to break down the average wall of masonry.

As the illustration indicates, the *Frea A. Busse* is built very low for bridge clearance in the Chicago River. The monitor tower was designed and constructed for telescoping for the same reason and can be raised or lowered in the remarkably short time of forty-five seconds for either operation.

An outstanding feature of the trials, in which both engines and pumps obviously operated well in excess of their designed and rated capacities, was the extremely scant pressure drop of only 18 pounds between the pumps and the turret nozzles. Considering that the turrets themselves are responsible for a tested pressure drop of 15 pounds at 150 pound pump pressure, the low resistance of the pipe lines between pumps and monitors is exceptional, causing a pressure drop of only 3 pounds. The fire main into which all pumps discharge is a loop of 10" seamless steel pipe, all joints welded, elbow turns consisting of Crane's standard welding fittings which are made with a radius equal to 1½ times the diameter. From this main loop 8" lines of seamless steel pipe, also welded, lead to the monitors and the tower. Valves are 300 pound Crane steel gates.

To the welded joint feature of these pipe lines and the smooth inner surface obtained by the method used is attributed the extremely low frictional and inertial resistance to the flow, equivalent to a 3 pound pressure drop in a length of about 50 feet between any one pump and the nearest turret. This extremely low line drop, incidentally, accounts for a considerable part of the excess performance indicated for the pumps and engines.

Water cooling of motors is effected through a heat exchanger system, two raw water pumps operating from the sea through Schutte and Koerting tubular heat exchangers, and the individual circulating pumps of the several engines pumping treated water from the exchangers through the jackets, returning it to storage tanks. Water jacketed exhaust pipes are cooled by water from the raw water pumps discharge through the exchangers. Cross connections are so arranged that any engine can, in case of necessity, take its jacket cooling water directly from the sea and discharge it overboard through exhaust pipe jacket.

Operation of fire pumps is controlled from the pilot house by special mechanical telegraph instruments, pressure gauges in the pilot house registering the discharge pressures from the several pumps.

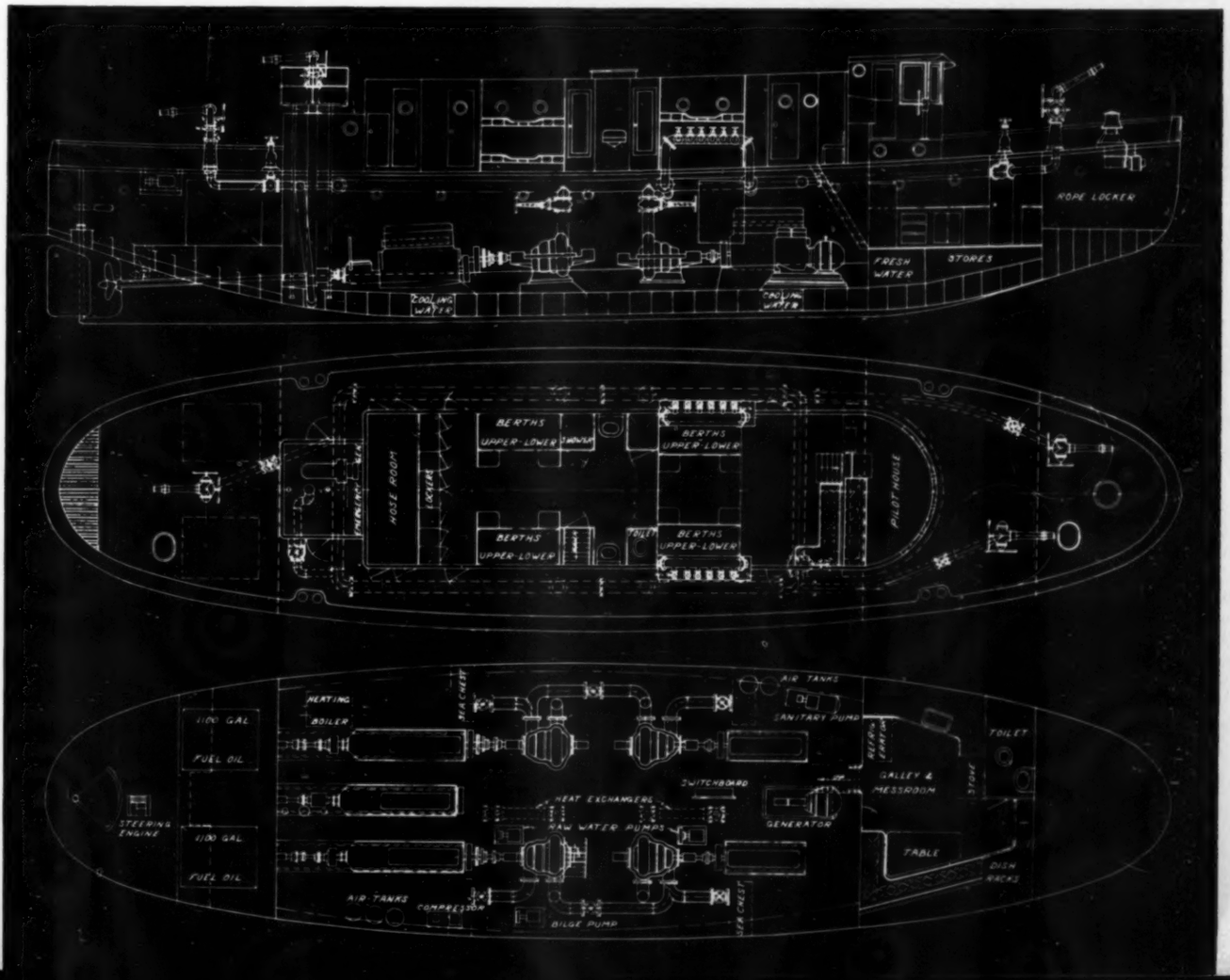
The boat is steam heated by a Kelvinator oil burning, automatically controlled boiler, piped to radiators and Clarage unit heaters in the various compartments of the ship.

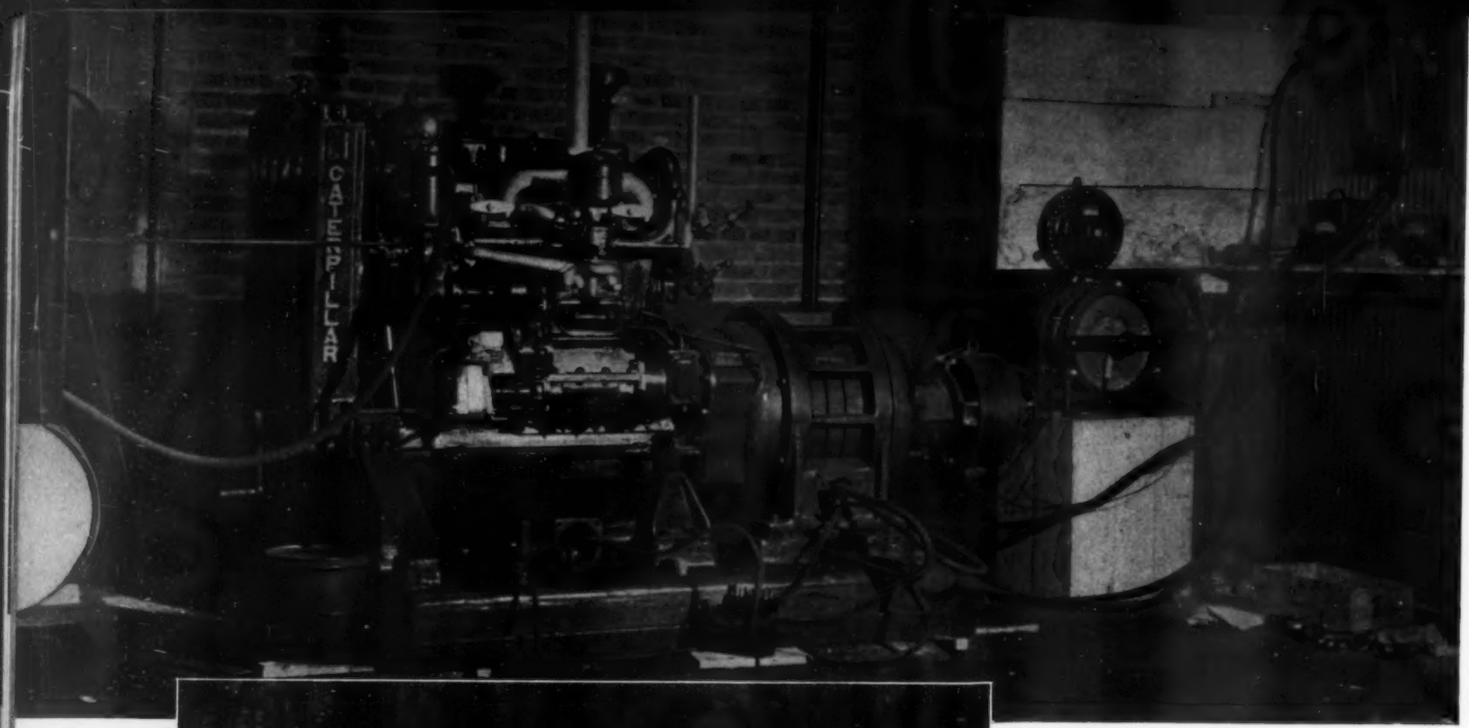
Starting air for the main engines is furnished by a 375 pound pressure system, including a battery of five air tanks and two Curtiss 2 hp. electric compressor units.

The ship carries its own fresh water system for drinking and culinary purposes, with a connection for plugging into the Chicago service main when lying at dock.

Living and sleeping accommodations are provided for a crew of eight men, with hot and cold water service to galley, lavatories and showers through a Duro pressure pump system.

Plans and elevation of the "Fred A. Busse" show clearly the accommodations and disposition of machinery.





The hastily improvised Caterpillar Diesel power plant which enabled the American Air Filter Company to operate during the recent Louisville flood. Left: One of the ten unsinkable steel rescue boats built by this company.

DIESEL FLOOD SERVICE AT LOUISVILLE

By WILLIAM K. GREGORY*

WHEN flood waters subsided, a few fortunate industries in Louisville found their plants undamaged but were unable to resume operations due to lack of electric power.

The American Air Filter Company, which is located in the general vicinity of Churchill Downs, was in this position. The plant was completely surrounded by water, and for six days could not be reached except by boat. The high water mark was within one foot of the factory floor level, but no material damage was done, and by January 30th operations could have been resumed if electric power had been available. No power was available, however, and the best promise for its restoration made by the Utility Company was ten days to two weeks.

*Mr. Gregory is Division Sales Manager of the American Air Filter Company, Louisville, Kentucky.

No heat could be supplied to either office or factory as an electric stoker was employed on the heating boiler, electric unit heaters furnished heat for the factory and an electric air-conditioning system served the office.

Something had to be done! The prospect of ten days to two weeks huddled over a few gas stoves in the office, and men milling around the factory in overcoats meant that little or nothing could be accomplished. It also meant a direct financial loss due to inefficient operation, and an intangible loss of prestige and good will due to failure to carry on correspondence and make shipments.

A Diesel generating set was the only solution to the problem which occurred to anyone, and after considerable scouting around, a 60 horsepower Caterpillar Diesel direct connected to a 30 kw. General Electric generator was located nearby. A few hours later this unit went into service, and remained in continuous operation for ten days except for brief shutdowns to change oil in the crankcase. A board, a box and a shelf served as the control panel. Laboratory type voltmeter and ammeter were pressed into service, and the entire installation was more or less thrown together, but it worked, and how!

With a normal connected load in excess of 250 horsepower it seemed that this 30 kw. unit driven by a Diesel having a maximum rating of 60 bhp. would do little more than operate the heating system, provide necessary lights and possibly operate a few small tools. It was a surprise to everyone, therefore, when one ma-

chine after another was placed on the line, and the plant was operating at better than 50 per cent of normal capacity.

The load was applied gradually at first and an operator was constantly in attendance to watch the instruments, adjust the field rheostat, etc. A sticker was placed on the ammeter to indicate the maximum load permissible. Large motors operating shears, brakes, presses, etc., were started by throwing them on and off the line repeatedly until they came up to speed, and during such periods the ammeter would jump past the marker for a few seconds and then settle back within the established limits.

A typical average operating load carried by this unit for twenty-four hours at a time is as follows:

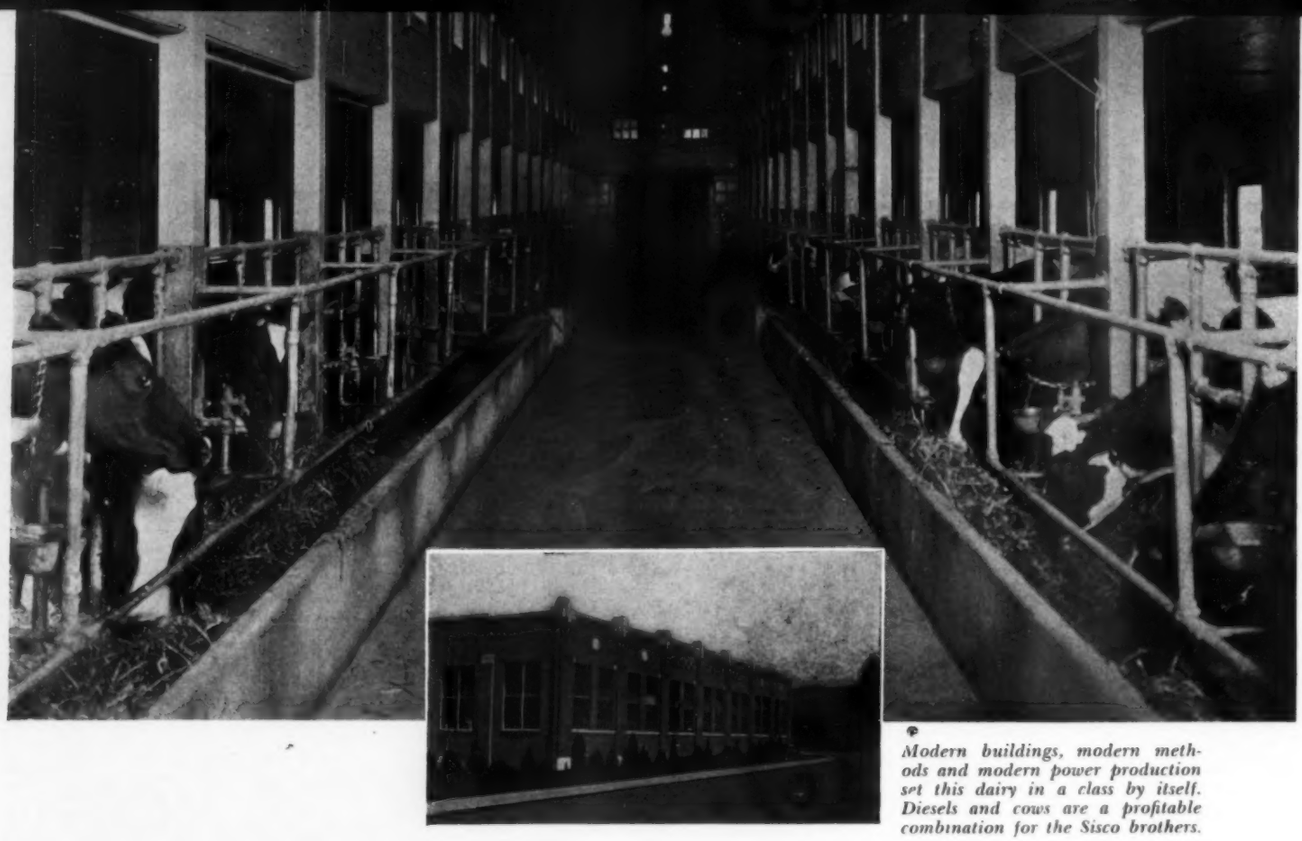
2	Motor Generator sets for welding	30 hp.
2	Power Brakes	20 hp.
1	Shear	7½ hp.
1	Tool Room Line Shaft	7½ hp.
1	Tool Room Line Shaft	5 hp.
1	Boiler Stoker	5 hp.
1	Air Compressor	5 hp.
3	Blowers for office heating plant	6 hp.
20	Unit Heaters for factory heating	5 hp.
	Total hp. of Motors Operating Simultaneously	91 hp.

In addition, 6,000 watts or more was used for lighting.

Of course, some of the motors were not called upon to deliver their full horsepower after the large machines they were connected to were brought up to speed, but even so, the average twenty-four-hour load for ten days was 42.7 kw., an overload of 40.2 per cent.

. . . . *And now please turn to page 66*

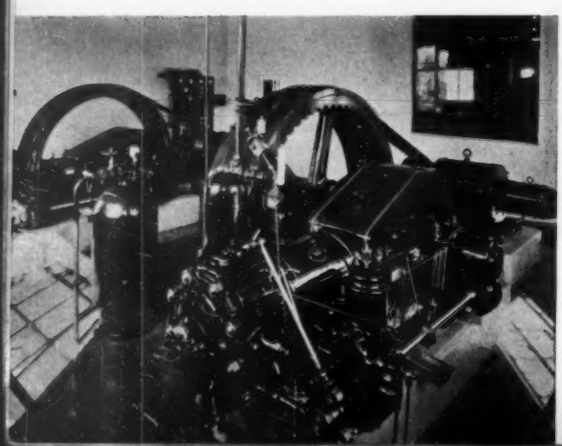
Four of the dozen machines which drew emergency power from the Diesel when utility power failed.



Modern buildings, modern methods and modern power production set this dairy in a class by itself. Diesels and cows are a profitable combination for the Sisco brothers.

SISCO DAIRY DIESELS

ABOUT forty years ago Mr. Sisco started a dairy business, beginning with one cow. The present Sisco Dairy Company, Inc., 66 Mt. Prospect Avenue, Clifton, New Jersey, attests to the success of that initial venture. Business constantly increased, especially after pasteurization was adopted. With this increased demand for milk and dairy products grew a corresponding demand for electrical power. With the erection of the new plant illustrated herewith, power costs assumed major proportions and a survey was instigated to determine ways and means to reduce this item of expense. The net result was to commission the engineering firm of Peet & Powers to install a Diesel plant.



The main generating equipment consists of two Ruston horizontal Diesels driving 35 kw. each Star Electric generators through Dayton V-belts. The engines are single cylinder units rated at 47 hp. at 290 rpm. and carry a 6'-9" flywheel. The bore and stroke are 10¾" by 19½" respectively. Auxiliary equipment consists of Teesdale automatic fuel transfer pumps, Goulds jacket water circulating pump for the closed cooling system, Davis paracoil exhaust heat economizers and silencers and dual automatic safety devices. Jacket water is cooled through Modine radiators which also heat the garage building.

In addition to the major savings in generated electricity of $2,600.00 annually, an additional $50.00 per month (estimated) is saved in the form of exhaust heated boiler make-up feed water for generating necessary process steam. At least $15.00 monthly during the winter can be added to the above for previously mentioned garage heat. A fuel storage tank of 6,000 gallons capacity was installed so that ample storage would be available for most attractively priced oil. The plant was designed on the basis of amortizing the mechanical equipment out of savings in about three years. Operations to date indicate that this estimate is approximately correct. The owners have spent considerable on the power house itself which, like the rest of their buildings, is of the finest construction and kept spotlessly clean. Since this item is entirely discretionary it cannot properly be included in amortization figures.

It is of interest to note that the installation of this Diesel plant resulted in no increase in personnel at the dairy. Previously employed workmen have taken over the operation quite successfully and start and stop the engines as required as well as synchronizing the generators on the line. Only one unit is running ordinarily although for short daily peak loads both are used. Noise and vibration are not noticeable.

DIESEL ENGINE VIBRATION CONTROL

By S. ROSENZWEIG

THE need of controlling machine vibrations is quite generally recognized today. Machine designers have done their share in scientifically balancing moving parts to eliminate vibration as far as economcally possible, but engineers well know that even for the most modern machinery rigid bolting to foundations is inadequate for the purpose of preventing vibration transmission. Today the accepted cure is to interpose a resilient medium in such a way that it will absorb the vibrations and prevent the mischief their wanderings cause.

Let it be understood at the very outset that vibration transmission into adjoining structures can be avoided by changing either the operating frequency of the machine or the elastic properties of these structures. This is in most cases practically impossible, and in any case exceedingly costly. Also, no vibration absorbers would be required if the sub-structure on which machine and its base are mounted were absolutely rigid. But there is nothing that is absolutely rigid. Thus we have the problem of vibration isolation.

If it were possible to attach a machine to an absolutely rigid structure it would operate without any perceptible oscillation. It is simply prevented from carrying out those movements which, if free, it would execute under the influence of the harmonic forces and moments of the moving masses and of the periodic variations due to cylinder gas pressures. If, however, the sub-structure is not rigid, as is necessarily the case, the forces set up by the machine would tend to put it into a vibratory motion having the same frequency as that of the machine itself. The basis of vibration transmission is thereby created. This transmission, moreover, may become extremely disturbing if the natural frequency of the sub-structure is similar to the operating frequency of the machine or its harmonics.

A foundation system if it is not to transmit objectionable vibrations must comply, therefore, with the following three requirements:

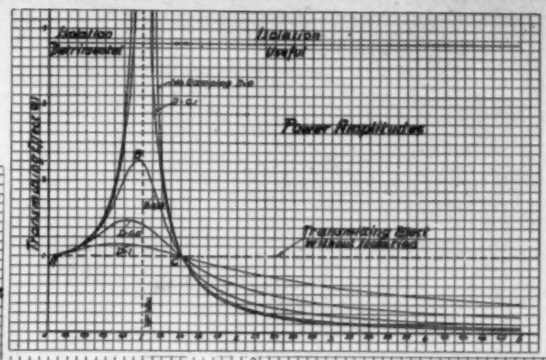


Fig. 1

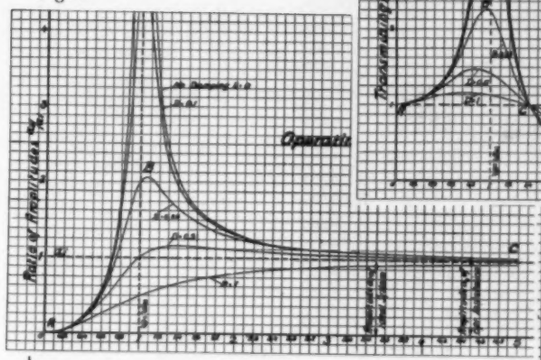


Fig. 2

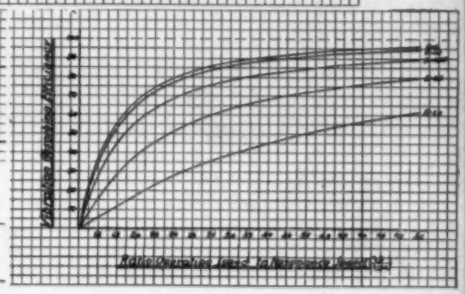


Fig. 3

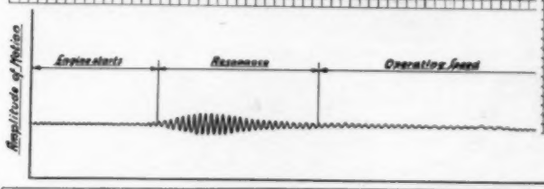


Fig. 4

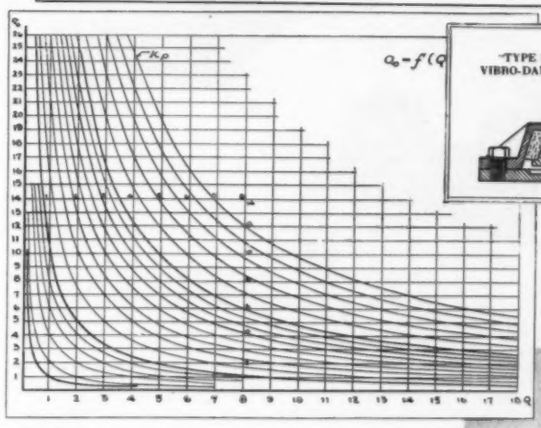


Fig. 5

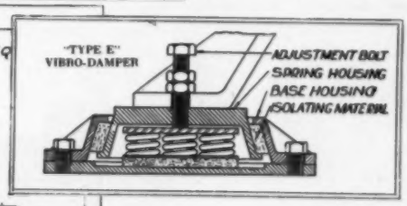


Fig. 6

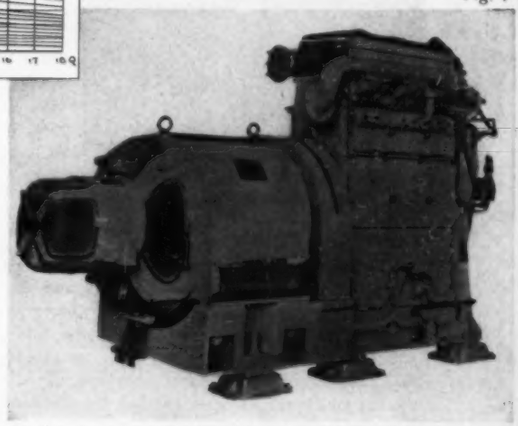


Fig. 7

1. The machine must operate without excessive oscillation.
2. The vibratory forces transmitted to the substructure must be reduced to such an extent that they will cause no disturbances.
3. The natural frequency of the sub-structure must be sufficiently removed from the forced frequency of the operating machine.

The solution of these problems can be carried through with absolute certainty of success. Careful mathematical calculations, to be sure, are necessary. Vibratory ills are cured only if diagnosed correctly and treated by a vibration engineer who is well versed in both theory and practice of this branch of engineering. Results obtained from actual installations of correctly designed and correctly arranged spring-suspended foundation systems, indicate that the practical condition can be met very closely through the theoretical calculations.

The first complete analysis of vibration isolation was worked out by C. R. Soderberg of the Westinghouse Company. It relates to vibration absorbers for suppressing undesirable effects

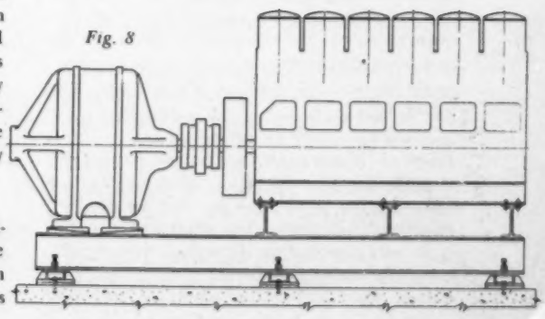


Fig. 8

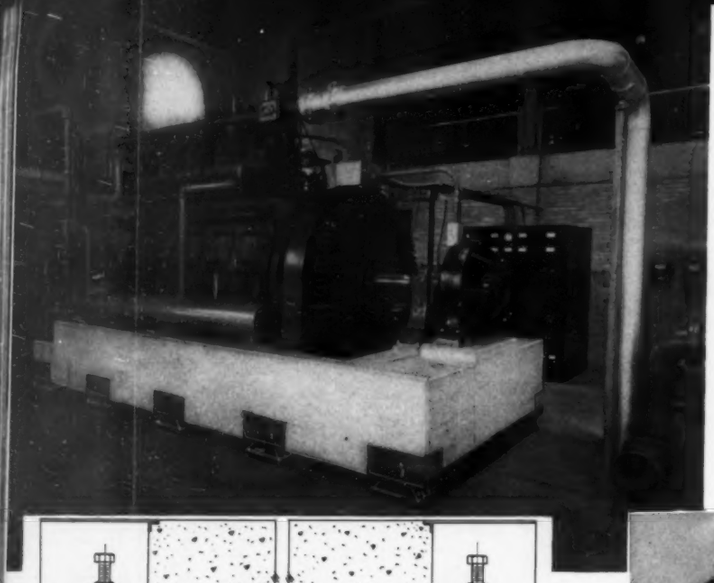


Fig. 9

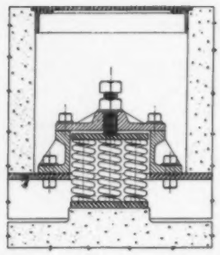


Fig. 10

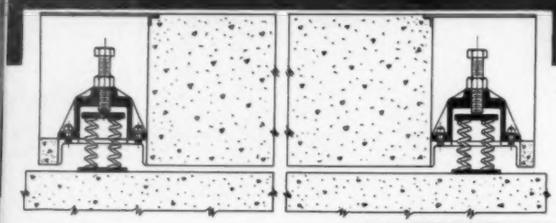


Fig. 11

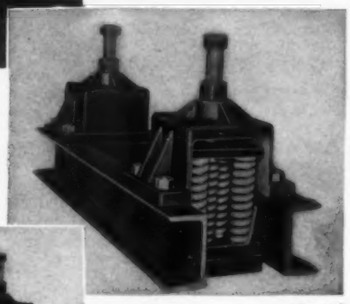


Fig. 12

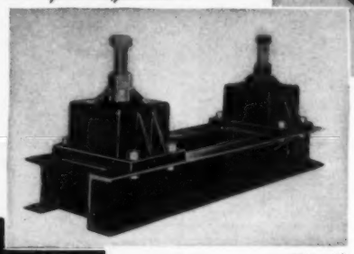


Fig. 13

Fig. 14

produced by periodically varying forces and has since served as a basis for all spring-suspension calculations. A diagrammatical representation of this analysis is shown in figures 1 and 2. Figure 1 represents the amount of the vibratory force which is being transmitted to the substructure in comparison to a rigidly mounted machine. Figure 2 represents the amplitude of motion which the spring-suspended foundation executes compared to the ideal system which is suspended free in space. The common abscissa for both diagrams is the ratio of the forced frequency (due to the operation of the machine and often corresponding with its revolutions) to the natural frequency of the vibration absorber ($\frac{W}{Wn}$)

Figure 1 illustrates several important points. If the frequency ratio ($\frac{W}{Wn}$) is less than 1.41, the isolation thus provided is not only useless, but actually detrimental. The transmitting effect is actually greater than if machine were rigidly attached to its foundation. When the frequency ratio is 1 – i. e. when the two frequencies are alike – the transmitting effect is a maximum, point B. The system is now operating at, or passing through, what is called the "resonance speed of the system." Only after the frequency ratio becomes greater than 1.41 is the vibration absorber actually absorbing vibrations, as the rapid drop of the curve below unity indicates.

Therefore, to make the force transmitted to the foundation as small as possible, the forced frequency of the operating machine must be large compared to the natural frequency of the vibration absorber. This ratio should be at least 3 to 1 – and in many cases considerably more – depending upon local conditions.

For any specific machine operating under a given set of conditions the normal operating speed and hence its resulting forced frequency is fixed. Therefore greater ratios between forced and natural frequency are obtainable only by reducing the natural frequency of the isolating medium. Up to certain limits such a reduction is not very difficult. But when the natural frequency must be made very small, as for instance to produce ratios where the curves flatten out and become nearly horizontal, this becomes very difficult. Sometimes it is, in fact, impossible of achievement. In any event these small natural frequencies and hence great ratios between forced and natural frequency and therefore lower transmitting effects are only obtainable with well designed vibration absorbers. Achieving this greater decrease in natural frequency requires careful design and a thorough understanding of the laws of vibration isolation.

Figure 3 represents the efficiency of the spring suspended system for varying frequency ratios ranging from 0 to 5. The curves are plotted on the basis of the values obtained in Figure 1. In Figure 2, line *ai* represents the amplitude of motion of the ideal engine suspended free in space. This amplitude is obviously constant because the frequency ratio of the ideal system is infinitely large. For the actual machine, amplitudes are small for the low frequency ratios, but gradually increase until they become large at resonance speed. One might compare this action of resonance with the action of a person on a swing, pushing himself in the right direction at the right time until an inordinately large amplitude is produced by the cumulative effect of small forces. From point B the amplitude decreases asymptotically, until it approaches that of the ideal system, point C. Here the frequency ratio is so high, the two frequencies being out of phase one with the other, that the mass cannot follow and to all practical purposes stands still. The amplitude of motion of the foundation system for the entire range of frequency ratios is plainly shown in diagram Figure 4. Note how this varies from the time the engine starts, through resonance, and up to operating speed. The curves shown in Figures 1 and 2 prove that for frequency ratios greater than 1.41, both vibration transmitting effect and amplitude of motion of the mass, become less and less and gradually approach a minimum.

Vibration isolation of 100 per cent with no oscillation of the operating system is impossible. However, for a frequency ratio of 5 to 1 and with zero damping, the amplitude of motion will be within 6 per cent of the ideal engine and vibration absorbing efficiency approximately 97 per cent.

The different curves in Figure 1 are drawn for different degrees of what is technically called "damping" and which refers to that part of the vibratory force dissipated by internal friction and converted into heat. Considerable damping is decidedly harmful in a vibration absorber when operated in the useful range, as it increases the transmitting effect. This is clearly shown in Figure 1. For machines operating at widely varying speeds, and sometimes during starting and stopping, it may be necessary to employ some damping to prevent excessive movement of the machine when passing through resonance. This factor should be taken into consideration when using steel springs because they have a damping coefficient of less than one-half per cent. However, by making the springs in the damper very soft, resonance speed will occur at a low engine speed and therefore be passed through so quickly that the

effect of resonance is hardly noticeable. Steel springs absorb vibrations entirely due to their high resilient qualities. On the other hand all organic materials when compressed and released are subjected to internal friction setting up this damping effect which, in natural cork, amounts to about 7 per cent and considerably more in compressed cork, rubber and gelatinous materials until it reaches a maximum of more than 90 per cent in lead. It is true that the effect of damping in the vibration absorber may be somewhat counteracted by making it more resilient, but the principal objection to damping is the destruction and deterioration which materials suffer when damping is high. The amplitude of motion is reduced by damping, the reason for which is obvious. As friction, whether internal or external, is introduced the motion is retarded and therefore the oscillation of the system decreases. However, at the frequency ratios at which the system must operate the difference in amplitude of motion between the system having zero damping and a system having, say, 0.5 damping is so slight that damping should be considered undesirable under all conditions for the reasons stated previously.

While in the last analysis the correct spring design and Damper assembly are of greatest importance, an improperly designed foundation may impair the functions of an otherwise well laid out isolation arrangement. Weight of foundation, correctly distributed in length and width, must be carefully calculated to provide, in conjunction with the natural frequency of the vibration damper, such amplitude of motion in the cushioned mass which is not excessive for satisfactory and safe operation. This calculation is essentially the work of the mathematician backed by actual installations and tests to check his calculations. The diagram shown, which represents the weight of foundation as a function of unbalanced forces and amplitude of motion of the cushioned mass (Figure 5), is the result of such work, enabling the designer to determine required weight of foundation.

Advanced types of steel spring suspensions for absorbing machine vibrations mark the highest development of isolation engineering. The efficiency of the steel spring is due to its extraordinary elastic properties and its unusual adaptability to all isolation needs. In these respects it has a decided advantage over any other isolating medium as the scope of its application is almost limitless since the proportions may obviously be varied over a wide range.

In actual installations, springs can be easily altered to suit conditions without requiring changes in the foundation. Moreover, in the most advanced mechanical devices of this character, the steel spring assembly is so constructed as to make the load carrying capacity critically adjustable both before and after installation — a most necessary feature where maximum efficiency is required.

The possibility of a broken spring or loss of resiliency from fatigue caused by continuous service in a spring vibration absorber is practically non-existent. The play of the spring due to the machine's vibrations or impacts is but a few thousandths of an inch at the most. Compare that with the action of an automobile valve spring closing and opening more than ¼" about 300,000 times during a short day's run. One seldom hears of a broken valve spring. Why? — because the endurance limit of a particular combination of wire size and spring dimensions may be so specified as to have a safety factor far exceeding the requirements of actual operation.

That steel spring suspension can provide isolating efficiencies approaching 100 per cent has been proved by its record in thousands of installations. Particularly remarkable are the results in absorbing periodic low-frequency vibrations of Diesel engines. Furthermore by giving careful consideration to all factors, particularly to the possible presence of unbalanced forces and moments, it is often possible to considerably reduce weight of foundation and in many cases dispense with it entirely.

The Spring-Dampers are by far the most versatile of all isolating products or materials. One type of this device as illustrated (Figure 6) consists principally of four units, i. e., a strong heavy base housing and base plate drilled for anchoring the damper to the foundation, a spring housing resiliently separated from the base housing and entirely suspended on springs, a number of cold-rolled oil tempered supporting springs for each Damper depending on its size, and an adjustment bolt which maintains the correct height of the Damper and regulates the tension on the springs. Under the proper loading the spring housing drops a few thousandths of an inch until it is entirely suspended on the supporting springs. Vibrations travel through the spring housing and spring adjustment plate to the springs where they are absorbed.

The conical design adapted for the Damper prevents any misalignment between two housings, and holds them together in a definite relation which is a fixed dimension for each Damper size. A tendency to misalignment is immediately counteracted by the greatly increased pressure set up between the conical surfaces which at the same time acts as a snubber against a vertical pull. For larger Dampers an isolated locking device is provided to serve the same purpose.

These Spring Dampers can be applied in three different ways to Diesel Engines. Figure 7 shows the units applied directly under the engine. This is only possible where unbalance is reduced to a minimum and where no inertia mass is necessary.

Figure 8 shows the Dampers arranged under a structural steel base. This is a much used method and is particularly adaptable to auxiliary Diesel Generating Sets aboard vessels.

Figure 9 shows the Dampers underneath a concrete foundation. This method of installation is used where an inertia mass is found necessary and where it is inconvenient to have a foundaton below floor level.

There are many instances where a machine must be mounted on a concrete foundation block and it is desired to have this foundation below floor level. The isolation of such foundations can be most effectively accomplished by spring devices, providing assembly is so arranged that all damper parts are easily accessible and removable and providing adjustment of springs can be easily effected even after foundation and machine have been installed.

To meet these requirements two systems have been evolved which solve a vibration problem of long standing. The U-Damper system is placed within the foundation supporting it by means of dampers and channel iron construction, while the O-Damper system is placed outside the foundation suspending it on Suspension Dampers. These two methods, though different in respect to construction and application, make use of the same isolation principles. Between these two methods every type and size of concrete foundation can be correctly isolated.

The cross sections and end view (Figure 10 and 11) show the assembly of the Type U-Damper system in relation to the foundation. Two channel irons (or more if required) extend the entire length of the foundation block acting as reinforcement for the concrete. Each channel iron is supported by rows of Dampers, placed at definite intervals. A firm union between Dampers and the channel iron is established by bolting the channel to the sturdy spring housing of each Damper. Through openings left in the concrete, spring housings are easily detachable from the channels and through openings in the channels provide complete accessibility for removing the springs and all other damper parts.

Figure 12 shows the complete Damper arrangement with a part cut away to show spring detail. Figure 13 shows the Damper arrangement as it would be imbedded in the foundation. Figure 14 is a perspective drawing of the Type U-Damper System isolating a Diesel engine and foundation. The channel irons run the length of the foundation on each side. Note how entire foundation and engine is raised off the sub-structure on the springs which rest in a saddle supported on the sub-structure.

As the channels are solidly embedded in the concrete foundation, the latter is of course also resiliently supported on the Dampers. The actual assembly of the Dampers and the pouring of the foundation over them are rather interesting and ingenious. First the sub-structure is poured. The sub-structure is made from 6" to 15" thick depending on the character of the soil on which it is poured. Next the spring saddles are placed in their proper positions on

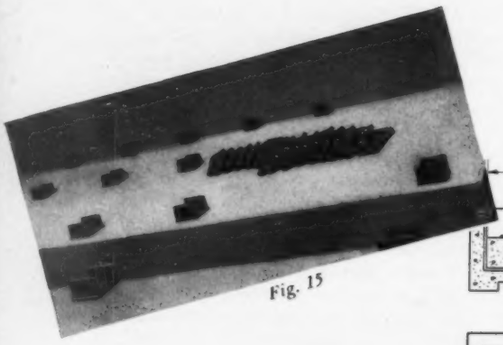


Fig. 15

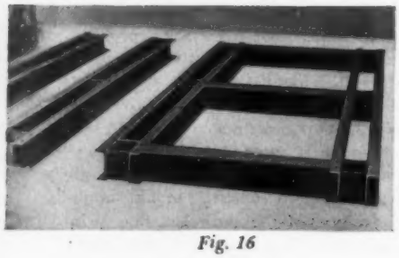


Fig. 16

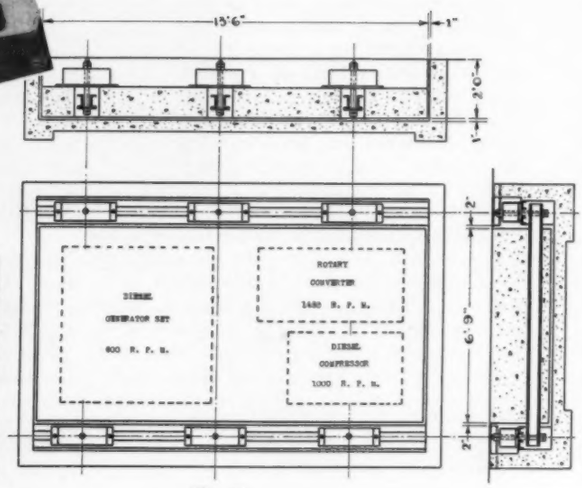


Fig. 18

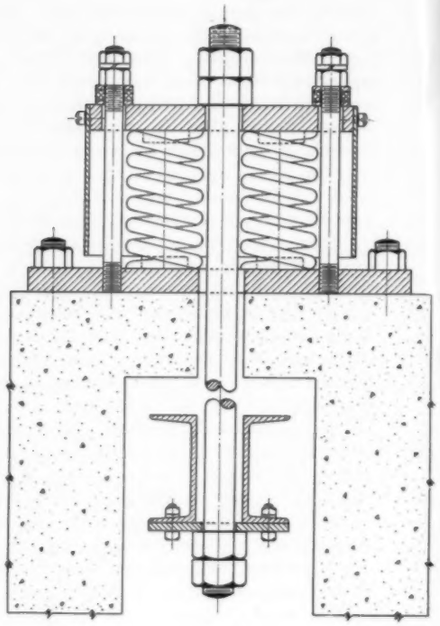


Fig. 17

the sub-structure (Figure 15 – note the top plates lying on one of the sub-structures). In the illustration are shown two sub-structures each of which will carry a foundation with two Diesel engines. Next the steel channels are fitted over these saddles as shown in Figure 16. Next forms are built for the foundation with provisions for openings over each of the saddles shown in Figure 15. Then the foundation itself is poured. Springs are next lowered into each of the saddles through the openings left in the concrete foundation. The top covers are then placed over the springs and are bolted to the channels. The adjusting bolts are then screwed into the top covers. By turning down on these adjusting bolts the entire foundation is raised and "floated" on the springs which rest on the sub-structure. Raising the foundation is a very simple task requiring less than an hour's time even for a fairly large foundation. The foundation is carefully relevelled and adjusted for load distribution, and everything is ready for quiet and vibrationless operation of engines. Previous to placing the channel irons a layer of asphalt felt is placed on the sub-structure. The foundation is poured on this asphalt felt so that when the foundation is raised on the springs there will be no difficulty due to the foundation adhering to the sub-structure.

The Damper designs cover a loading range of 5,000 to 15,000 pounds per Damper. The flexibility of assembly, however, is such that practically any other loading and special load distribution is easily attainable.

In the Type O-Damper system, Dampers are placed around the sides of the foundation pit, supported on concrete or steel constructed shelves. To the spring housing of each Damper is bolted a steel rod which extends downward through the Damper and supporting concrete to a point within a few inches of the bottom of the foundation pit. The lower end of each steel rod is attached to a steel beam which is embedded in the foundation block, Figure 17. Thus the foundation block is literally hung from the O-Dampers, and the vibrations resulting from machine operation may pass up through the vertical rods into the spring housing to be safely absorbed by the springs.

The O-Dampers are of simple but sturdy construction made entirely of steel. The spring housing is separated from a heavy base plate by rugged steel coil springs whose length is determined, as explained in the introduction, by the vibration frequency of the operating machine. The sides of the Damper are of sheet steel. The entire Damper is accessible to a remarkable degree for spring changes or other adjustments as may be seen in Figure 18, being located just a few inches below floor level of machine room.

Pouring of the concrete foundation can be carried out in identically the same manner as described for the Type U-Damper. Lifting, adjusting, and levelling of the foundation is effected by means of the vertical suspension rods.

The Type O-Damper has some very interesting and valuable features. One of its outstanding characteristics is its relation to the foundation, being practically always located a considerable distance above the point of gravity of machine and its foundation to which it thus insures stability. Its sturdy ruggedness and accessibility have been referred to. Its two-fold adjustment by means of the suspension bolts and by changes in the spring housing is noteworthy, and the possibility of radically changing the length, height, and width of the Damper gives it a wide range of application. By providing a special flexible design of suspension rods the Damper having now six degrees of freedom will safely absorb vibrations due to torque reactions and moments of reciprocating engines besides vertical impacts.

These systems of spring suspensions (fully covered by patents) are remarkably effective in isolating foundations of such machinery that is particularly difficult from an isolation standpoint, as slow speed engines.

The foregoing is a complete analysis of theory and practice covering many thousands of installations. What does all of this mean to the engineer contemplating the installation of machinery? It conclusively proves the error of an existing common impression that a material is an efficient vibration absorber under all conditions merely because it is elastic. There is no cure-all isolator. Every installation is a problem in itself. Careful calculations are necessary to determine weight of foundation and volume of spring material that is required. The specifications of the architect and consulting engineer should give responsible manufacturers of isolating materials fullest latitude in applying these requirements. After all, the cost of the isolating equipment represents only a small part of the total cost of the installation. Careful adherence to the fundamental principles developed is therefore of much greater importance than some slight reduction in cost. Vibratory ills are cured only if diagnosed correctly and treated by a vibration engineer who is an expert in this highly specialized field.

RIGHT DOWN YOUR ALLEY

New Records Daily for Low-Cost Maintenance with Nonpareil Diesel Oil

Records of operating economy with Nonpareil Diesel Oil vary only in relation to the mechanical operating conditions under which it is used. With ideal test conditions, spectacular records have been made. Under ordinary operating conditions, users continually report "the lowest cost lubricant we have found."

A typical example of an economical maintenance record is submitted by a large milling company. Four diesels are operated, three 800 HP units and one older 360 HP unit. Before installation of the 800 HP diesels many types of diesel oil were submitted for test in the 360 HP engine. Nonpareil Diesel Oil came out with flying colors and was adopted on the new units.

Then—after 14,000 hours of operation, the new diesels were taken down and inspected. There were no stuck rings and only .006 to .013 of an inch wear on any cylinder. A remarkable record when you consider that 14,000 hours is equivalent to almost two years operation—24 hours a day.

You can get the same lubricating efficiency, with reduced consumption as well. That's what is meant by low cost lubrication with Nonpareil Diesel Oil.

NONPAREIL DIESEL OIL MEDIUM
NONPAREIL DIESEL OIL HEAVY
NONPAREIL DIESEL OIL EXTRA HEAVY
STANOILS—SEVEN GRADES

Ask for this Booklet on

"DIESEL CYLINDER LUBRICATION"

It discusses the causes of diesel cylinder wear and how to combat them—the causes of carbon formation—methods for determining where faulty operation lies and recommended lubricants for more economical operation. This interesting monograph as well as others listed are yours for the asking. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Illinois.

"Diesel Engine Bearing Lubrication"
"Lubrication of Diesel Air Compressors"
"Diesel Engine Air & Fuel Cleaning"

"Sure, you know Jack—
he's SAVED this company PLENTY!"

"That's Jack, the Standard Lubrication Engineer—he's a real asset to this plant. We first met him the time we had so much trouble with the bearings on No. 2 engine. I'll never forget it. He looks like a white-collar guy—but you should have seen him that day. He was right in there every minute—and grease up to his ears. He sure pulled us out of a hole. He's been 'Jack' around here ever since—and just between us, he's meant 'jack' to this plant."

Multiply this opinion by hundreds, even thousands, and you will have an idea of the friendliness with which Standard Lubrication Engineers are received throughout their territory. And it's only natural. Standard Lubrication Engineers have a service to give you. A helpful service. Their one interest—to cut your lubrication costs . . . their sole reward, your satisfaction with the lubrication in your plant and the Standard Oil products you use.

Do you know *your* Standard Lubrication Engineer? By all means get acquainted; it will be profitable to you. Call your local Standard Oil (Indiana) office and ask for a Lubrication Engineer.

Copr. 1937, Standard Oil Co.

STANDARD OIL COMPANY (INDIANA)

CORRECT LUBRICATION

BETTER COMPRESSION

...that's THE THING

Many oils break down in the heat of a Diesel, leaving residues that can stick piston rings in their grooves. Then you have blow-by, loss of compression and consequent fuel waste. Texaco Oils correct these troubles.

HIGH COMPRESSION is the very essence of power in any Diesel. To maintain compression, piston seal must be maintained on *all four sides* of each ring.

You will get the high compression you want by using the proper grade of Texaco Algol or Ursa Oil. Both Algol and Ursa have the body to withstand high temperatures and heavy pressures. Distilled and filtered, they keep rings, valves, and ports free from hard carbon.

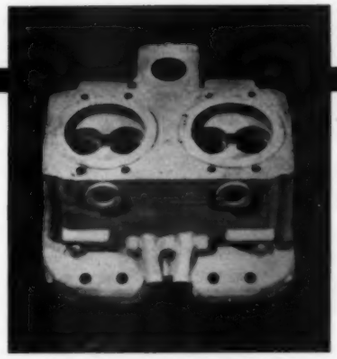
Using these Texaco Oils for the first time, you'll be surprised how clean your engine will be, when you take it down at inspection time. Then you'll know why more Diesel h.p. is lubricated with Texaco than with any other brand.

Texaco Engineering Service is available through 2020 wholesale warehouses throughout the United States.

THE TEXAS COMPANY
135 East 42nd Street • New York City

TEXACO *LUBRICANTS FOR ALL TYPES OF DIESELS*

...more fundamentals in the search for reliability



Because it forms a part of the combustion chamber, the diesel cylinder head is subjected continuously to the high temperatures which are required in the diesel cycle.

Ability to distribute heat is therefore a cardinal requirement in cylinder heads; superior ability to distribute heat is a natural characteristic of Aluminum.

Consider in detail just what the superior heat conductivity of Aluminum does in the head, and how these details enhance reliability:

Better heat distribution reduces the thermal stresses which constitute one of the direct sources of failure by cracking. Reliability is directly enhanced.

Better heat distribution makes possible cooler valve seats and cooler valves. This is not only a contribution to reliability, but also to lower maintenance because valves require less frequent regrinding.

Each of these advantages of Aluminum Cylinder Heads is a definite contribution to reliability. ALUMINUM COMPANY OF AMERICA, 2141 Gulf Building, Pittsburgh, Pennsylvania.

Be sure . . . THE HEADS ARE

ALCOA · ALUMINUM

En-ar-co DIESEL OILS

Cut Costs!

At the Sign of the Boy and Slate There is an En-ar-co Lubricant for Every Requirement

To the users of Diesel Engines we offer the result of experience and effort devoted exclusively to the production of Quality Lubricants.

En-ar-co Lubricants actually cost less because they do a better job.

Remember—a Diesel Engine is many times more expensive than the oil which it requires. Protect this investment with En-ar-co Diesel Oils. It pays to buy the best.

THE NATIONAL REFINING COMPANY
HANNA BUILDING • • • CLEVELAND, OHIO

Four Alnor Pyrometers Protect No. 2 Park Avenue

IN THE No. 2 Park Avenue Building are four 450-hp., 6-cylinder, 4-cycle Worthington Diesels furnishing the entire electric service for the building.

Each engine is equipped with an Alnor Round Flush Type Pyrometer mounted on a panel board with other control instruments as shown in view at left — Alnor Pyrometer being located at upper right.

Whenever you see a Worthington Diesel installation invariably you will find it Alnor Pyrometer equipped.

It will pay you to acquaint yourself with the advantages of using "Alnor" Pyrometers and the variety of types and sizes available.

Write for complete catalog

ILLINOIS TESTING LABORATORIES, Inc.
423 North LaSalle Street • Chicago, Illinois

Testing Engineers and Manufacturers of "Alnor" and "Price" Pyrometers
The Products of 35 Years' Experience

Use "Alnor" Pyrometers—*The Diesel X-Ray*

25 Tons of Power Economy . .

ready for shipment to Southern New England Ice Company

☆

Literally, we may be wrong to speak of measuring power economy in tons. But, two large Superior Diesel engines like this 8-cylinder of 420 horsepower and the one of 315 horsepower, which are being installed for Southern New England Ice Company, Bridgeport, Conn., can effect economies in power cost in many plants which would weigh pretty heavy in silver dollars, in a few years . . . We would prefer to measure possible economies in dollars and cents, for you, in a survey of your power requirements. We are prepared to make that survey for you without cost or obligation—you will be the sole judge of whether the investment is justified. Savings may pay the entire cost, quickly. Ask us about it!

THE NATIONAL SUPPLY COMPANY
OF DELAWARE
SUPERIOR ENGINE DIVISION
LOS ANGELES, CALIFORNIA SPRINGFIELD, OHIO PHILADELPHIA, PA.

Superior DIESELS

HEAVY DUTY MODELS: 50 to 810 H.P., 250 to 720 R.P.M. • HIGH SPEED MODELS: 25 to 150 H.P., 1200 to 1800 R.P.M.

SPECTRUM ANALYSIS, A MODERN AID IN DIESEL ENGINEERING

By B. J. VON BONGART

DURING the past, Diesel engineering has been somewhat of a hit-or-miss affair. The phenomena inherent in combustion were totally unknown; in fact the process of oxidation was only partially understood. Yet Diesels were built that did run! The engineer testing an engine on-the-block noted its performance and behavior, and whatever data he obtained was turned over to the designer who in turn was to produce an engine giving a certain desired result. The interpretation of the test-stand data was a guessing contest in most cases, and not infrequently, the one who could conjecture the loudest, won. The charge often heard, that the suppositions of the early technicians were wrong at least twice as often as they were correct would, off hand at least, indicate that cogency had little weight at the time. But in all fairness it must be said, that the Diesel engineers of our fathers' days had precious little to work with. Knowledge cannot be gained without facts. To have none but fragmentary data and that of an indecipherable nature, is poor equipment, ill-fitted for profound pontification. Definite phenomena, though inevitably producing a given result, could not always be interpreted; and lest we forget, things do not necessarily happen according to preconceived notions.

Spectrum analysis is not new; it was first used by the chemist-scientist Bunsen, the inventor of the well-known Bunsen burner. With a spectroscope one can examine the spectra of various gaseous substances and determine their behavior during combustion. One finds that each element contained within the gas has its own characteristic bright-line spectrum. It may be simple, as in the case of a sodium flame or complex, as in the case of iron vapor, which has several hundred lines. The spectroscope is an ideal and a very delicate method of analyzing substances.

Those who can remember the open gas-jet (not the Welsbach mantle type) used in our fathers' and grandfathers' time for illuminating purposes (the gas-range of today is also an example) must or rather should have noticed that the flame is not of one color; and if we examine the flame by means of a spectroscope, we find

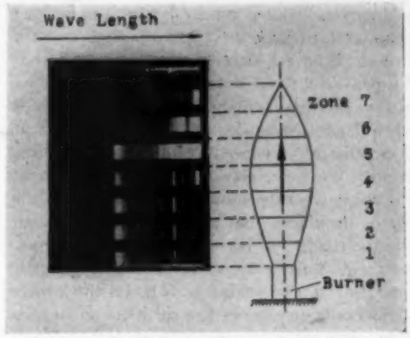
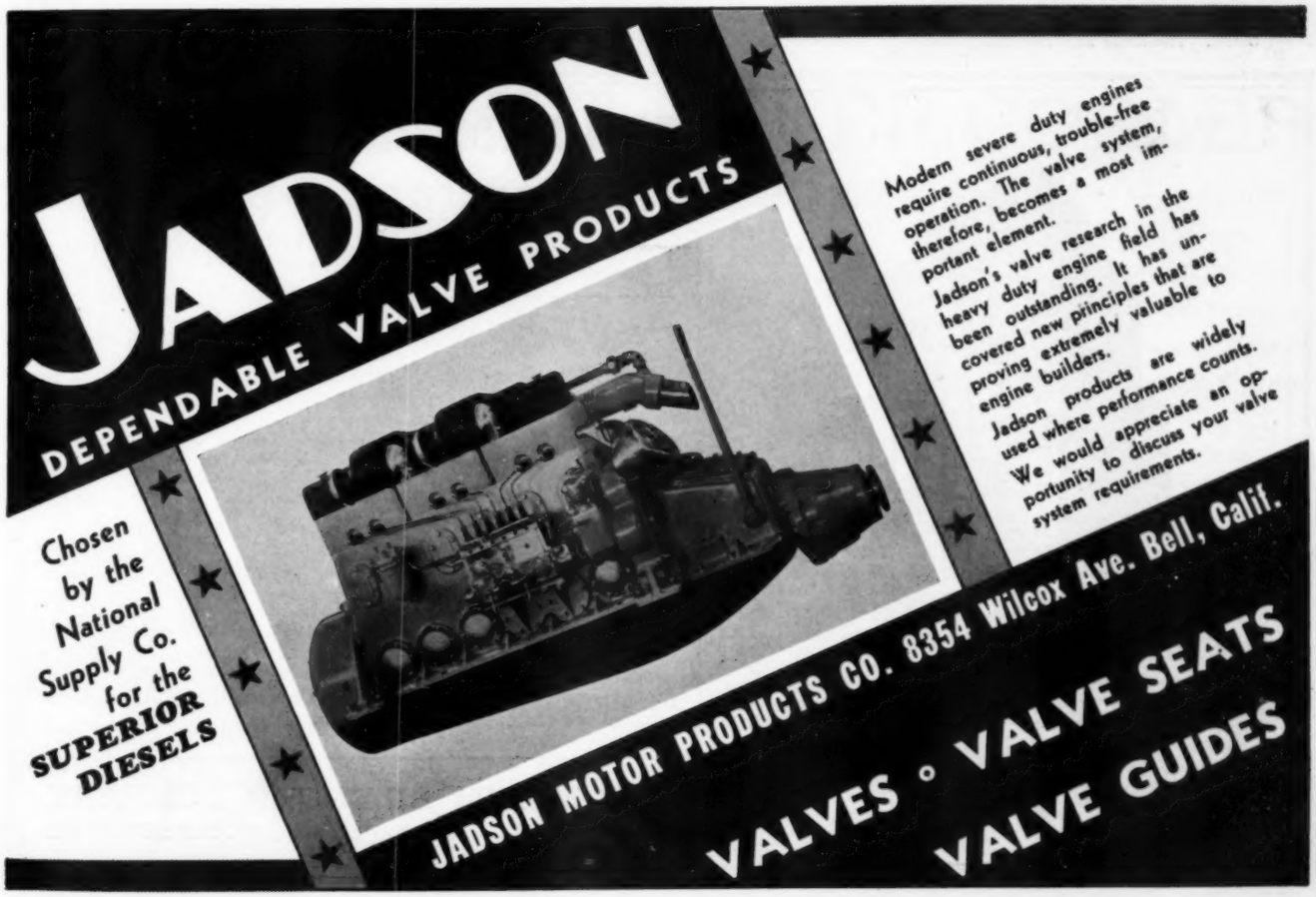


*Fig. 1 — Oil-gas flame, Bunsen type burner**

that the flame consists of horizontal zones, each like a rainbow, of distinct hues, i.e., having a different spectrum pattern of vertical bands. If we now measure the heat intensity of the flame at different points, we further find that the heat varies for the divers zones, and also, that the heat intensity is independently indi-

*The author is indebted to Prof. Dr. Neumann for some of the illustrations shown in this article.


JADSON
DEPENDABLE VALVE PRODUCTS
Modern severe duty engines require continuous, trouble-free operation. The valve system, therefore, becomes a most important element.
Jadson's valve research in the heavy duty engine field has been outstanding. It has uncovered new principles that are proving extremely valuable to engine builders.
Jadson products are widely used where performance counts.
We would appreciate an opportunity to discuss your valve system requirements.
Chosen by the National Supply Co. for the SUPERIOR DIESELS
JADSON MOTOR PRODUCTS CO. 8354 Wilcox Ave. Bell, Calif.
VALVES ◦ VALVE SEATS
VALVE GUIDES

cated by the color spectrum of the particular zone. Moreover, by the delicate method of spectroscopic analysis we find that the heat intensity varies even within any one zone. In fig. 1 is shown an oil-gas flame as emanating from a Bunsen type burner.

Before we can continue towards analyzing the phenomena taking place within an engine's cylinder during the combustion period, we must first of all have a clear conception of just what happens in a flame burning in the open atmosphere (no high compression pressure). The open flame is exceptionally helpful to us in that it permits us to view the entire process at first hand. We note, viewing the flame-spectra of the zones from the mouth of the burner to the tip of the flame, that all spectra vary, indicating the changes of the chemical process of combustion. Since a Bunsen type burner adds air (oxygen) to the gas before it leaves the burner — essentally or more or less complete amalgamation — the net result is the formation of bands within the flame, clearly visible in the illustration up to the fifth zone. Each zone is a comparatively complete spectrum, the hues varying from violet to cardinal-red and even beyond. In the sixth zone, and all the more so in seventh zone, the bands are fewer, due to the fact that the oxygen which mixed with the gas ahead of the mouth of the burner has been consumed; hence the flame in the sixth and seventh zone obtains the necessary oxygen for combustion only from the surrounding atmosphere. Thus we may pronounce the dictum, less air equals fewer bands. The flame now receiving a lesser amount of oxygen, bands can no longer form, and instead of bands there appears a continuous radiation, indicating the existence of solid C and gaseous CO. Whether or not the solid carbon and the poisonous carbon monoxide are subject to further chemical reactions towards their final transformation into CO_2 and H_2O is problematical. If a tin pan blackens while held over the gas flame, it is a sure indication that the carbon is not fully consumed; the existence of CO can be proved by instruments.

Of greatest import to us are the so-called swan-bands, which lie in the visible field. They are caused by solid carbon particles that are rejected during combustion. This carbon does not oxidize immediately but radiates an immense amount of heat towards the combustion space.

Any given (high) temperature possesses a distinct hue, and each color is inherently of a given wave length; that is, has its own frequency. A partial number of colors are tabulated in Fig. 2.

SOURCE	Hue or Color	Wave Lengths in Centimeters	Frequencies in Kilocycles/ Second
Oxygen, atmos.	Red	0.00007594	3948×10^8
Hydrogen	Orange	0.00006563	4568×10^8
Sodium	Yellow	0.00005896	5085×10^8
Mercury	Yellow	0.00005770	5196×10^8
Mercury	Green	0.00005461	5490×10^8
Hydrogen	Blue	0.00004861	6168×10^8
Calcium	Violet	0.00003968	7556×10^8

Fig 2 — Wave Lengths and Frequencies of Color-Spectra.

While it may be best to actually measure the lower temperatures (less than 600° F.), the heat intensity of really high temperatures can be closely determined from the color spectrum. In 1800, Herschel placed the bulb of a sensitive thermometer on a spectrum (sun's rays) and found, that the rays falling upon it produced a rise in temperature. This indicated rise was much greater in the red end of the spectrum than in the violet end. When he placed the bulb beyond the ultra-violet, there was no heating effect, and conversely, beyond the infra-red there was a marked increase in temperature. Today we know not only that any given (high) - temperature sends out waves of a given color, but the heat produces an entire spectrum of variegated hues. The number of bands — each of a given hue — depends upon the temperature; and the maximum heat radiation from any given color, also depends upon the temperature. In Fig. 3 are listed a few temperatures tabulated as to heat radiation.

725° F.	Maximum heat radiation	from	yellow	to	green
975° F.	"	"	"	"	infra-red bands
1000° F.	"	"	"	"	dark-red bands
1200° F.	"	"	"	"	cardinal-red to green
1450° F.	"	"	"	"	light-red to blue
3000° F.	"	"	"	"	white heat to violet

Fig. 3 — Spectra heat radiation

Thus we see that the color spectrum is a perfect means of establishing heat intensity. When the dark colors predominate, zone 1 of Fig. 1, the spectrum reveals that the heat intensity is not

MAXIM SILENCERS

DO *DOUBLE DUTY* AT

NUMBER TWO PARK AVENUE!

1. Exhaust Silencing ***2. Pulsation Dampening***

EACH of the four 450-hp. Worthington Diesels is equipped with two Maxim exhaust silencers. One, Model DO4F, very effectively quiets the normal Diesel exhaust so that no one, unless actually in the engine room, can detect the presence of these engines operating in the heart of Manhattan.

In addition, the Maxim engineers designed and built a special unit for each engine to dampen exhaust pulsation. Otherwise the exhaust upon entering the stack would have interfered wtih the draft for the steam heating boilers, and as well, caused the building to vibrate severely.

The chances are 99 to 1 that Maxim standard silencers will solve your exhaust problem. For the 100th case, however, the experience and engineering of the Maxim organization can produce a tailor-made unit which will satisfactorily handle the most unusual and obstinate exhaust conditions.

THE MAXIM SILENCER COMPANY

HARTFORD - - - CONNECTICUT

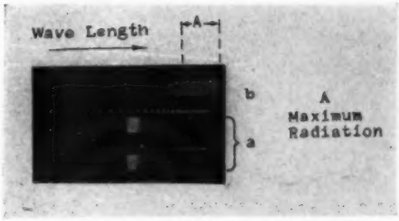


Fig. 4 — Spectra, Diesel engine combustions

great. If however the lighter hues prevail (zones 6 and 7), we are dealing with intense heat and maximum radiation. If we provide an engine's combustion chamber with a quartz window so that the heat rays can be picked up by a spectroscope, we are enabled to record irrefutably the entire phenomena of combustion by means of photography.

The completeness of the mixture of fuel and air is the decisive factor in the combustion process. To be sure, poor mixtures of fuel and air will burn, but not completely. There is bound to be an excess residue of carbon, and the formation of carbon monoxide is unavoidable. Such combustion is a waste of fuel and cannot but result in making an engine perform in an erratic manner. The best method of assuring an intimate mixing of the carbon molecules (fuel droplets) with the oxygen molecules (air) is by means of turbulence. That the full significance of turbulence is not understood even today is borne out by the fact that comparatively little use is made of chamber constructions fostering adequate turbulence. The spectra shown in Fig. 4 explains the situation.

In a well designed Diesel engine, that is to say, an engine with a thoughtfully arranged combustion chamber, the combustion taking place shows a band-structure, spectra (a) of Fig. 4. The chemical reactions inherent in combustion progress over radical bands, spectra (a). But if the fuel and air mixture is imperfect or haphazard, so that the carbon and oxygen molecules have difficulty in "finding" one another, or if their affinity is hampered, then the spectrum of the combustion will not show bands but a continuity radiation, i.e., radiation of CO and of solid C, spectrum (b). Fig. 4.

It is assumed that the foregoing is now clear in the reader's mind, and thus we now turn towards analyzing the combustion phenomena which takes place within a Diesel engine. In Fig. 5 we have a spectrum of an "open chamber" Diesel engine; i.e., an engine where fuel is injected into — and where the subsequent combustion takes place within the engine's main combustion chamber.

As can readily be seen, such a compression chamber produces mainly radiation — unless provisions are made for a more perfect union of fuel and air — which, when dissected spectrally according to wave-lengths, consists essentially of continuity radiation of carbon and carbon

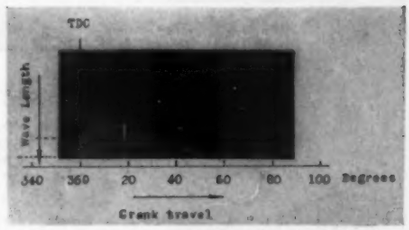
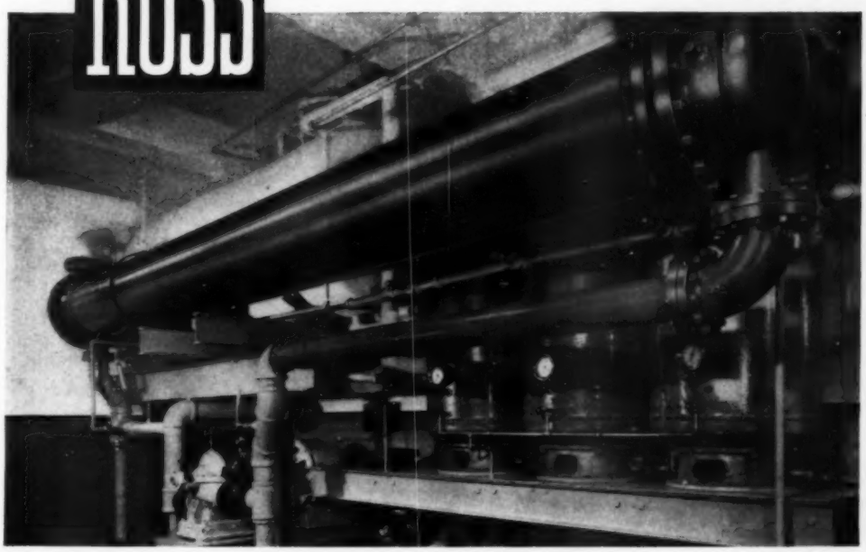


Fig. 5 — Spectrum, Open-chamber Diesel

monoxide. The only band noticeable after combustion has set in is the OH band. The cause for its existence lies in the disintegration of the H_2O which formed during the combustion process, manifesting itself finally in a "wet" exhaust.

To the discerning, the spectrum of Fig. 5 reveals quite a few things. First: the temperature rise is sudden, the maximum temperature T_2 is reached within 6° after T.D.C., indicating that the engine operates with the so-called typical Diesel-pounding. Yet the maximum temperature as reached is very low; thus the engine produces a very low b.m.e.p. Second: the haze or fog formation is of great magnitude and occupies the distance from approximately 5° to 35° of crank travel. Third: the combustion temperature ends in rat-tail fashion, the useful heat (hence pressure) as early as about 45° past T.D.C., yet burning extends to past 80°; clearly indicating that this means heat minus power.

ROSS JACKET WATER COOLER

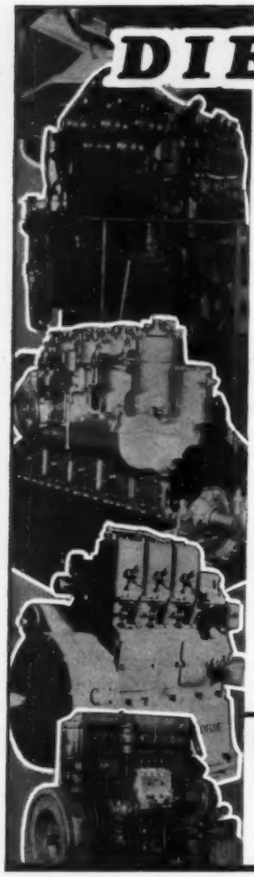


• • • selected by Worthington Pump & Machinery Corp. for jacket water cooling on four of their 450-hp Diesel Engines recently installed in power plant of Park Avenue Building, New York City.

For standardized or special jacket water coolers and lubricating oil coolers . . .

Consult ROSS

ROSS HEATER & MFG. COMPANY, INC.
DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORP.
New York, N. Y. . . . 1407 WEST AVENUE, BUFFALO, N. Y. . . . Chicago, Ill.



DIESELS for

TRAINS
TRACTORS
BUSES
PLANES
CARS
SHIPS
TRUCKS
FARMS
YACHTS
GENERATING
IRRIGATING
PLANTS

the PRACTICAL EQUIPMENT
of the Hemphill Diesel Schools includes practically every make and type of Diesel engine built in America—from 5 hp farm service engines to large marine types. The products of forty-one American manufacturers, and four European builders are represented. ALL for one purpose; to provide the most thorough and practical Diesel training possible to its students.

fuel system LABORATORIES
are as complete as the engine equipment. Considerable of the laboratory testing equipment has been designed and built exclusively for student instruction. New equipment is added to both the laboratories and the shops as rapidly as new developments are proved in the field.

the "MARCH of DIESEL"
To users of engines interested in the facilities of the Hemphill Diesel Schools for thorough instruction of students, and to men considering a course of Diesel training we will gladly send the 32 page book "March of Diesel" — without obligation.

HEMPHILL DIESEL SCHOOLS

are located only in the cities and at the addresses listed below. They are not connected with any other schools of any kind.

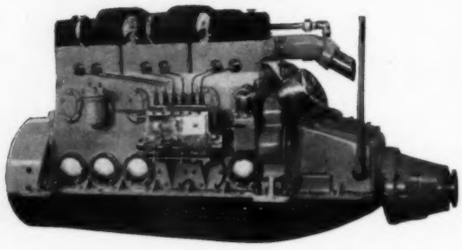
BOSTON . . . . . 110 Brookline Avenue
NEW YORK . 31-28 Queen's Blvd., L.I.C.
DETROIT . . . 2340 W. Lafayette Blvd.
CHICAGO . . . . . 2020 Larrabee Street
MEMPHIS . . . . . 421 Monroe Avenue
LOS ANGELES . 2121 San Fernando Rd.
SEATTLE . . . . . 503 Westlake North
VANCOUVER, B.C. . 1365 Granville St.

m-21-4pr

JOES
REVERSE AND REDUCTION GEARS

also standard on

National
SUPERIOR DIESELS



2 Exclusive Features

1 Joes Gears drive direct through clutches instead of through locked pinion gears.

2 Joes Gears lock tightly to crank shaft instead of driving through loose splines

• National Superior Diesels from the first have been equipped with Joes Reverse and Reduction Gears. Exhaustive tests led to the adoption of Joes Gears and perfect performance has proved the great value of JOES two vital and exclusive features—direct driving and vibration dampening.

For taxi and tug boat service, Joes Gears are now available in 100% reversing ratio.

•

SNOW & PETRELLI MFG. CO.
FOX STREET, NEW HAVEN, CONN.

FREE—1937 Vest Pocket "Rules of the Road"

A quite different performance is depicted in Fig. 6.
Ignition begins within the pre-chamber before

T.D.C reaching its own $T_{max.}$ at about T.D.C. Comparing Fig. 6 with the frequency chart shown in Fig. 2, we find that we are here dealing with ultra short waves, the color varying between blue and green. A distinct drop is noticeable some 8° past T.D.C., at which point actual ignition within the main chamber begins. To be sure, what takes place within the pre-chamber of this particular engine is not actual combustion: the wave lengths are too short for that; it is merely an *aurora borealis*, beautiful to behold perhaps, but fundamentally

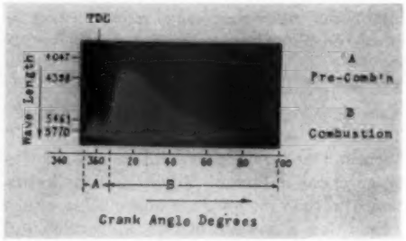


Fig. 6 – Spectrum, pre-chamber Diesel

only a prelude or overture to what is to follow, namely the actual combustion. Here, $T_{max.}$ is reached some 16° past T.D.C., proving that the engine's operation is pliably smooth. The maximum temperature as reached here gives a good average b.m.e.p. Useful temperature is generated beyond 60° crank travel, although some after-burning takes place up to 93°. While the spectrum Fig. 6 shows far superior performance when compared to Fig. 5, yet it does not represent the *ne plus ultra* of excellent Diesel engineering. In this particular instance, as perhaps with most pre-chamber designs, an exhaust residue remains from the previous combustion. Carbon particles pollute the incoming fresh-air charge and the remaining CO_2 and perhaps also CO prevent complete aspiration. Yet in this instance at least, the carbon particles that have remained within the pre-chamber are heated by the ensuing compression. Towards the end of the compression stroke, the heat (of the compression) causes the carbon particles to glow, and in turn help to increase the temperature of the fuel-air charge, thus reducing the delay angle of the actual ignition. In order to understand the action played by the residue-carbon particles we must bear in mind that only the first part of the chemical reaction taking place within a combustion chamber up to the point of actual, visible ignition is endothermic; the second part, the combustion of the fuel, is exothermic. In other words, up to the point of visible ignition, heat must be given off by the air to the fuel molecules, but once an actual flame has been formed and combustion has begun, the disintegration of the peroxides that have been formed during the chemical reaction of combustion give off heat, the latter reaching other fuel particles, which in turn accelerates further combustion. On the whole, an exhaust residue

is an evil, but we see here that an evil sometimes and under appropriate conditions, may produce a virtue!

In conclusion, it is needless to say, not all open-chamber Diesels make as poor a showing as depicted in Fig. 5. Some designers provide for turbulence of some sort by shrouding the intake valves; others make use of two injection nozzles; still others provide for extremely fine and even fuel atomization, etc. All these factors have their effect upon the sum total.

What is really needed is a chamber design permitting the initial combustion (ignition) to produce spectra of multi-colored bands, not merely low temperature (and hence low-pressure) hues from green to blue. $T_{max.}$ should be reached not earlier than 20° past T.D.C. (so that the engine may operate with a soft rhythm) and combustion should end in a broad tail some 60° past T.D.C.

DIESEL PROGRESS BOUND VOLUMES

BOUND VOLUMES of the twelve issues of DIESEL PROGRESS issued during 1936 are now available. We have received a number of requests for such bound volumes, so we put through an order for fifty.

The bound volume this year consists of two units, one contains January through to June and the other contains July through to December. Each unit is bound in the same style as the *Diesel Application Planbook* — plastic spiral, so that all pages lie flat.

Whilst the supply lasts these bound volumes may be obtained for $7.50 express prepaid. Simply send remittance for $7.50 to DIESEL PROGRESS, 2 West 45th Street, New York, N. Y.

POSITIONS OPEN for internal combustion designers and layout men of extraordinary ability. Write full particulars, personal interviews granted by appointment only. General Machinery Corporation, Hamilton, Ohio.

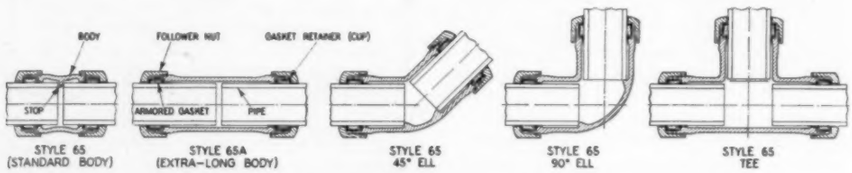
LIQUIDOMETER
DIAL TYPE
TANK GAUGES
(Remote Reading)
For use on Diesel operated ships, cranes, locomotives, municipal and private power plants
THE LIQUIDOMETER CORPORATION
LONG ISLAND CITY, N. Y.

RUSTON DIESELS
Save $3,000 Annually at the Sisco Dairy
Power at a fraction of the usual cost—¾ cent or less per kilowatt-hour—is an everyday experience with heavy-duty, reliable RUSTON Diesel generating plants 7½ to 1500 hp. medium or slow speed, 4,500 watts upward. Instant starting from cold without blow torch or electric starter—no high-pressure air needed for fuel injection—4-cycle principle—lubricated automatically—no trained operator required—packless fuel pump—low maintenance expense. Plants built to your specifications; for all types of industrial service.
PEET & POWERS, Inc.
70 E. 45th St. - Dept. R - New York
Sizes 7½ HP. Upward
See page 46 of this issue

DIESEL POWER AT ITS BEST!
STATIONARY... MARINE... POWER GENERATION...
Before you decide on *any* power plant, see how much more F-M Diesels have to offer. For full information, write for Bulletin 81, Fairbanks, Morse & Co., 900 South Wabash Avenue, Chicago, Ill. 34 branches at your service throughout the United States.
FAIRBANKS-MORSE Diesels
107 Years of Precision Manufacturing
Power, Pumping and Weighing Equipment
6873-OA 40.116

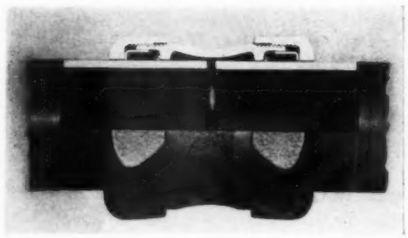
PIPE THREADING ELIMINATED BY STANDARD FITTINGS

"TIME out" for cutting pipe to exact lengths, threading, grooving, flaring, or screwing up joints in cramped quarters, is no longer necessary, according to the latest announcement from the S. R. Dresser Manufacturing Company, 406 Fisher Avenue, Bradford, Pa.



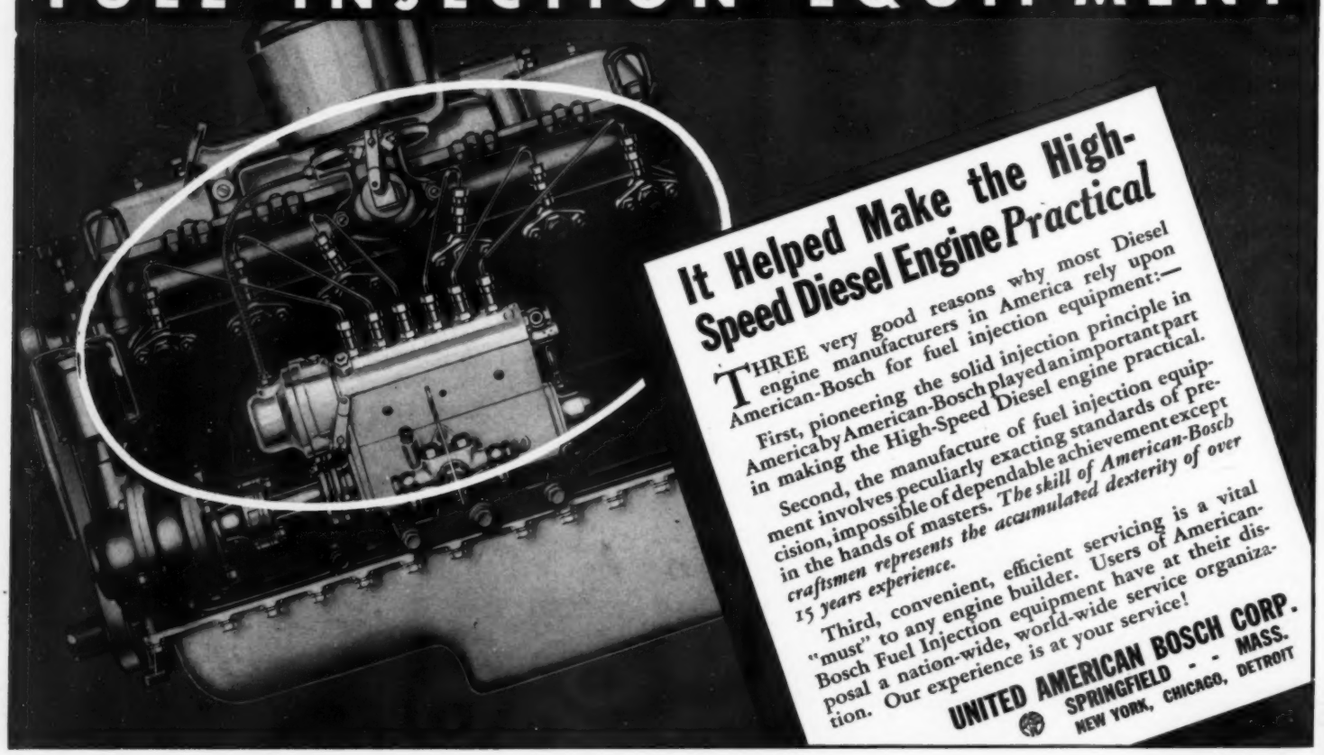
With the standard line of Dresser Style 65 Fittings just announced, nothing but an ordinary wrench is needed to complete a joint in a few moments.

After inserting the plain-end pipe into the fitting (which comes completely assembled), it is only necessary to tighten two threaded octagonal follower nuts with a few quick turns of the wrench. As this is done, resilient "armored" gaskets at each end of the fitting are compressed tightly around the pipe, forming a positive seal. The resulting joint, Dresser engineers point out, is not only permanently tight but absorbs normal vibration, expansion and contraction movement, and permits deflections of the pipe in the joint. If the pipe is already threaded, it can also be joined in the same way.



The complete line of Style 65 Fittings includes: standard and extra-long couplings, ells (both 45° and 90°), and tees, all supplied in standard steel pipe sizes from ½" I.D. to 2" I.D., inclusive, black or galvanized. These fittings are recommended by the manufacturer for simplifying joint-making and repair work on both inside and outside piping, for oil, gas, water, air, or other industrial lines. The basic principle is essentially the same as that used in other styles of the well-known Dresser Coupling.

AMERICAN-BOSCH
FUEL INJECTION EQUIPMENT



It Helped Make the High-Speed Diesel Engine Practical

THREE very good reasons why most Diesel engine manufacturers in America rely upon American-Bosch for fuel injection equipment:—

First, pioneering the solid injection principle in America by American-Bosch played an important part in making the High-Speed Diesel engine practical.

Second, the manufacture of fuel injection equipment involves peculiarly exacting standards of precision, impossible of dependable achievement except in the hands of masters. *The skill of American-Bosch craftsmen represents the accumulated dexterity of over 15 years experience.*

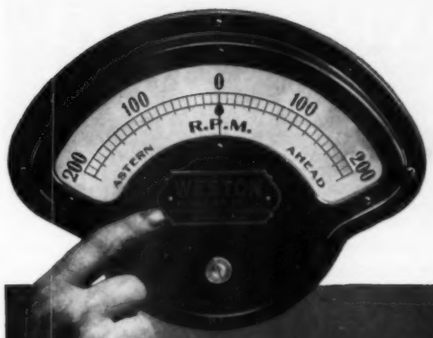
Third, convenient, efficient servicing is a vital "must" to any engine builder. Users of American-Bosch Fuel Injection equipment have at their disposal a nation-wide, world-wide service organization. Our experience is at your service!

UNITED AMERICAN BOSCH CORP.
SPRINGFIELD - - MASS.
NEW YORK, CHICAGO, DETROIT

NEW MODEL ALNOR PYROMETER

To meet the ever increasing demand for a small exhaust temperature pyrometer, the Illinois Testing Laboratories, Inc. have added the above illustrated unit, type 3023, to their regular line of instruments. This small, compact Diesel pyrometer with its round, flush-type case is suitable for panel or engine frame mounting on the thousands of small Diesels now going into automotive and stationary service. It fills a definite need in the smaller size ranges.

Overall dimensions are: Diameter – 4 inches and depth – 2¾ inches. The latter figure includes the lead terminals on the back of the case. The selector switch which makes contact with these terminals to give each individual cylinder temperature reading can be furnished with 2, 4, 6, 8, 10 or 12 points with a scale range of 600, 800, 1000, 1200 or 1600 degrees Fahrenheit. Where ever small Diesels operate and owners want a small, accurate and compact exhaust pyrometer permanently wired and mounted, this latest "ALNOR" will find enthusiastic reception. For further details address inquiries to The Editor.



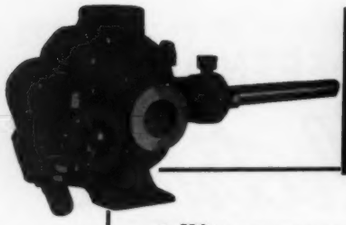
DEPENDABLE *Electrical* R. P. M. INDICATION

IN PILOT HOUSE AND ENGINE ROOM —aboard the CARMELITE

There's no doubt about engine R.P.M. aboard the new tug "Carmelite." A WESTON Indicator is mounted in the pilot house . . . another is mounted below at the engineer's station. Both are wired to the one dependable WESTON Magneto mounted on the engine. No matter how speeds fluctuate, these indicators follow all changes instantly and smoothly. And readings are always dependable, for with electrical indication there is no flexible shafting to vibrate, and wear. Simple, electrical connections between magneto and indicators complete the job. Accurate . . . adaptable to any requirement . . . easy to install . . . and virtually free from maintenance troubles . . . WESTON Electrical Tachometers should be your choice for every need. Let us send you complete data . . . Weston Electrical Instrument Corporation, 579 Frelinghuysen Avenue, Newark, New Jersey.

WESTON Tachometer Indicators are available in various sizes and shapes, with scales calibrated in any range of R.P.M.

WESTON *Instruments*



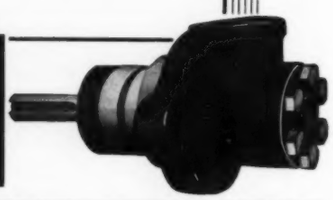
VIKING PUMPS
for your TOUGH
DIESEL JOBS

• Viking pumps are designed and produced for a variety of Diesel Engine services . . . are used as standard equipment by many leading engine manufacturers . . . pumps that are ideal for pressure lubricating service, auxiliary fuel oil injection, transfer and vacuum service.

Every pump employs the famous Viking Patented Principle, "A Gear Within A Gear". . . which assures efficient operation dependable service and exceedingly low operating cost. Pumps are available to meet your varied capacity requirements and essential installation needs. Enjoy "perfect performance," equip your Diesel Engines with Viking Pumps.

We have prepared detailed bulletins on Pumps for Diesel Engine Service . . check your pumping needs carefully and then write. We'll be glad to send you bulletins and price list.

VIKING PUMP CO.
CEDAR FALLS, IOWA



Fittings

. . . THAT MEET
YOUR SPECIFICATIONS

DESIGN your own . . . or select a Weatherhead design . . . you will find quality and accuracy that meet your most exacting specifications.

Weatherhead fittings for diesel service include inverted . . . S.A.E. . . . compression . . . or your own design—made by specialists in fitting design and manufacturing.

Weatherhead also supplies all manner of screw machine products. Send your specifications for an estimate.

THE WEATHERHEAD COMPANY
CLEVELAND, OHIO

LONDON LETTER No. 17

. . . . *Continued from page 39* . . . .

The machinery consists of two two-stroke cycle single-acting, trunk-piston directly reversible, airless-injection Diesel engines of the B. & W. type, developing together 5,100 ihp. at about 160 rpm.

Built by Krupp Germania Werft, the passenger and cargo motorship *Don Esteban* is to operate in the Philippines and between those islands and Hong Kong.

Length overall	279 ft. 0 in.
Length on water line	271 ft. 0 in.
Breadth	37 ft. 3 in.
Height to main deck	17 ft. 7 in.
Height to top deck	24 ft. 0 in.
Draught	15 ft. 6 in.
Speed	18 knots

The propelling machinery consists of two directly-reversible single-acting airless-injection four-stroke engines built by the Krupp Germania Werft. Kiel: each engine has eight cylinders 430 by 550 mm., and develops 1,750 bhp. at 330 rpm. The brake mean effective pressure at full load is 107 lbs. per sq. in., this output being possible because scavenging and supercharging is carried out with twin Krupp-built Roots-type blowers, giving an air inlet pressure of 4¾ lbs. per sq. in. above atmospheric.

The last of the trio, the Kronprinsessan Ingrid, is operating as a ferry across the 60 odd miles between Gothenburg and Frederickshaven. The vessel was built by Frederikshaven Vaerft and Flydedok A/S, Polar Diesel machinery being installed, so that the hull is Danish and the propelling machinery Swedish. She is designed as a one-class ship with a yacht-like appearance, and holds a certificate for 400 person, and carries about 30 automobiles. She is 210 ft. long, the beam being 36 ft. and the depth 14 ft. 5 in. The power, provided by two eight cylinder two-stroke single-acting Polar trunk piston type engines, is 2,200 bhp., and the service speed 16 knots.

Finally, here are some particulars of a very interesting new motor cargo ship built by Wm. Pickersgill & Sons, of Sunderland, and engined by the North-Eastern Marine Engineering Co., Ltd., Wallsend-on-Tyne. The Hylton, as she is called, is notable for being the first vessel completed employing the new North-Eastern marine Diesel and belongs to the 12-knot 9,200 ton class of vessel. She is 445 ft. long, 56 ft. 2 in. in the beam and 28 ft. 4 in. deep.

Built as a self-contained unit, driving its own cooling water, forced lubrication and bilge pumps, the main engine has six cylinders with a diameter of 620 mm., or about 24 7/16 ins., the piston stroke being 1,300 mm., corresponding to 51 3/16 in. As the engine rating is 2,150 bhp. at 106.5 rpm., the brake mean effective pressure is 112 lb. per sq. in. The maximum output is 2,600 bhp. at 114 rpm., at which the brake mean effective pressure is practically 128

lb. per sq. in., the piston speed being approximately 910 ft. per minute at 106.5 rpm., or practically 970 ft. per minute at the maximum revolutions. In connection with the pressure-charging system, with a corresponding increase in the mean pressure, it is, of course, generally known that the heat stresses are no greater than with an engine which takes its air suction direct from the atmosphere, and, in consequence, is unable to burn the same specific amount of fuel per cycle as with the alternative method.

In the Hylton, the engine has the turbo-supercharger attached, and no means are provided for cutting it out of service. This is a result of considerable experience with these machines, which have long periods of trouble-free operation to their credit. The unit in the Hylton was built by Messrs. Richardsons, Westgarth & Co., to Brown-Boveri designs, and comprises a single-row impulse gas turbine coupled to a single stage blower.

The trials of the Hylton were carried out during the latter part of a January gale, yet despite this the ship behaved very well and answered her controls perfectly. The fact that the engine is supercharged with a blower turning at 6,500 rpm. would lead one to expect a deal of engine-room noise and vibration, but this was disproved during the trials. The engine is undoubtedly a well-built unit and the workmanship displayed in its construction does every credit to the builders.

SUPPLY LIMITED

WE have but a hundred and eleven copies of the *Standard Practices* left on hand. This book has enjoyed a remarkable sale. It was published by the Diesel Engine Manufacturers Association late last year and has become the bible of the consulting engineer, Diesel salesman and prospective Diesel engine user.

And logically so, it contains a mass of vital information pertaining to standard performances, equipment and definitions. The cost of Diesel power. The selection of engine sizes for a given load. Power plant buildings. Engine construction. Governors and speed regulation. Erection data. Fuel oil storage and handling. Lube oil systems. Cooling water systems, etc., etc. Everything you need to know on Standard Practices — and the price of this unique book is but TWO DOLLARS. Subject to the supply now on hand we offer our readers this book — and heartily recommend it to them.

DIESEL PROGRESS, 2 W. 45th St., New York

Enclosed find $2.00, send me a copy of *Standard Practices* postpaid.

Name .....

Address .....

.....

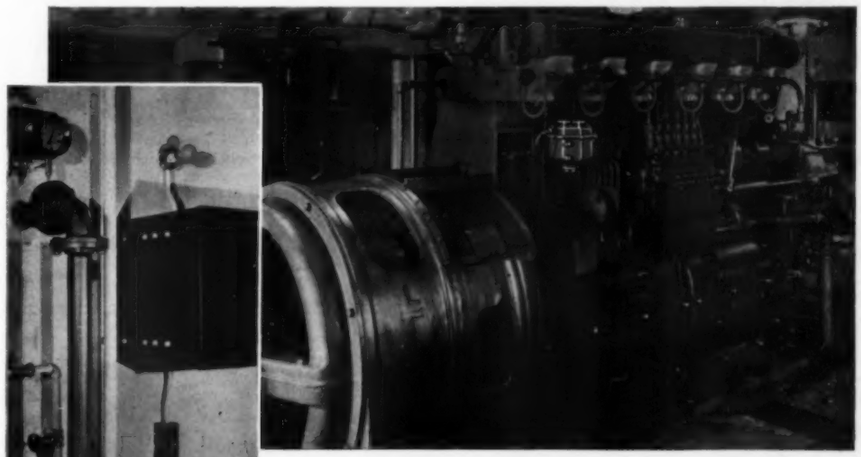
DIESEL POWER — Engines, Generator Sets

• COMPLETE PLANTS •

1250 H.P. Nordberg (2)
840 H.P. Fairbanks-Morse (2)
750 H.P. Busch-Sulzer (4)
450 H.P. Busch-Sulzer (2)
360 H.P. Fairbanks-Morse (2)
270 H.P. Worthington (1)
240 H.P. Nelseco (8)
200 H.P. DeLaVergne (2)
180 H.P. Fairbanks-Morse (2)
130 H.P. DeLaVergne (1)
110 H.P. Anderson (1)
100 H.P. Standard (1)
75 H.P. Fairbanks-Morse (1)
60 H.P. Worthington (1)
50 H.P. Superior-Otto (1)
50 H.P. International (1)
25 H.P. Fairbanks-Morse (1)

AUXILIARIES • EQUIPMENT • SERVICE • SUPPLIES
Conditioned, Rebuilt—Fully Guaranteed
ENGINEERING • SALES • INSTALLATIONS

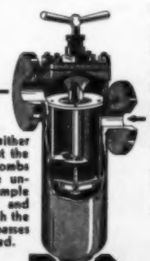
A. G. SCHOONMAKER CORPORATION
36-44 HUDSON STREET • Telephone BErgen 4-5300 • JERSEY CITY, N. J.



There's more than an academic interest in clean oil at N.Y.U.

• New York University's new power plant is still another notable Diesel installation in which CUNO *Continuously Cleanable* FILTERS play their vitally important role of insuring clean oil. The 300 HP High Speed McIntosh & Seymour Diesel shown has three CUNO fuel oil FILTERS, while the wall mounted CUNO Auto-Klean FILTER to the left is the unerring guardian of the lubricating oil system of another engine in the set. All three engines are CUNO equipped.

CUNO *Continuously Cleanable* FILTERS



Schematic section of a typical CUNO FILTER, showing direction of flow. Your substance enters the filter case and passes under gravity, pressure or suction head through the closely spaced filtering discs which catch the suspended solids. Then, rotation of the entire element, either manual or mechanical, against the stationary cleaning blades, combs out the filter and drops the unwanted substance to the ample sump below. The filtered and cleaned substance rises through the interior of the cartridges and passes out through the outlet indicated.

It's CUNO's steady uninterrupted dependability here at N.Y.U., as elsewhere, that marks it the ideal strainer unit for the Diesel Power Plant . . . Whether it's the first or the millionth gallon, CUNO's efficient metal discs reject all foreign substances which commonly contaminate Diesel fuel and lubricating oils . . . and, the BIG point is, CUNOS are *continuously cleanable while in service!*

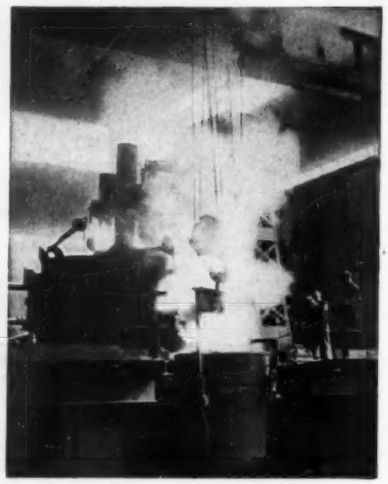
We'll be glad to show you how these small, space saving units can save you expense on pumps, valves, liners, rings and bearings . . . and provide new freedom from the menace of shutdowns. Ask for the details now.

CUNO
ENGINEERED FILTRATION
CUNO ENGINEERING CORPORATION - MERIDEN, CONN.

CUNO ENGINEERING CORPORATION
Dept. 40, 290 So. Vine St.
Meriden, Connecticut
Gentlemen: Please send me bulletin of CUNO FILTERS for service on _____
_____
and information on your confidential engineering service.
Name _____
Address _____
City & State _____

National Forge and Ordnance Company

Irvine, Warren County, Penna.



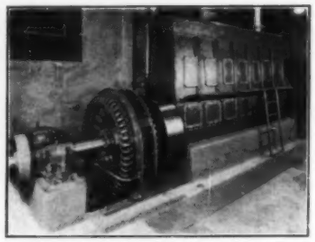
All National Forge and Ordnance Company products are manufactured from fine quality Basic Electric Steel.

Complete control of all processing from selection of the melting charge to the finished condition is National Forge and Ordnance Company's guarantee for maintenance of quality in crankshafts and various other types of forgings furnished to leading manufacturers in the Diesel industry.

BASIC ELECTRIC STEEL FORGINGS

Carbon, Alloy, Corrosion Reistant and Special Steels Smooth Forged, Hollow Bored, Rough or Finished Machined, Heat Treated to Specifications. . . Forging Quality Ingots Pressed or Hammered Billets.

8½ MILLS PER KW!



THEY USE A BUCKEYE DIESEL

● This 262½ HP., 175 KW., Buckeye Diesel Generator set pulls 150 to 175 KW., operating 90% of the time — not even shutting down on week ends.

Their Engineering Department writes: "Taking into consideration fuel and lubricating oil, labor, depreciation and fixed charges, we are generating power at an average cost of 8½ mills per KW."

This is just an example of the reliable and economical service produced with Buckeye Diesels.

Let us show you how much a Buckeye can save in your plant. Write on your Company letterhead.

SIZES 40 HP. UP TO 600 HP.

THE BUCKEYE MACHINE COMPANY

Engine Builders Since 1908

LIMA, OHIO

DIESEL

MECHANICS and TECHNICIANS

The most exclusive Diesel Training School on Atlantic Coast. Combination Home Study, including six weeks' practical shop work.

Information and Circular on request.

NEW YORK DIESEL INSTITUTION

47-51 RECTOR ST., NEWARK, NEW JERSEY

738 Broadway (Home Office) Albany, N. Y.

For Dependable Low Cost . . .
DIESEL POWER—30 to 185 H. P. Inclusive

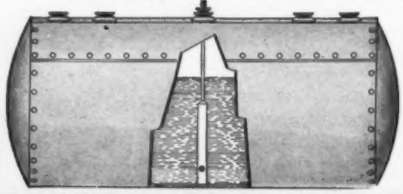
Wire or Write to . . . **POWER MANUFACTURING COMPANY** . . . MARION, OHIO

Victor ENGINES

PETROMETER DISTANT READING

For the BEST DIESEL **INSTALLATIONS**

TANK GAUGES



PETROMETER CORP.

1 Star Sq., Long Island City, N. Y.

DIESEL FLOOD SERVICE

. . . . *Continued from page 45* . . . .

Operating cost, including fuel oil, five changes of lubricating oil (oil changed every forty-eight hours) and an attendant at 50c per hour, figures 1.7c per kwh. Excluding the attendant, whose presence was required due to overloading and lack of proper control instruments, the cost per kwh. was considerably under 1c, even though oil was changed at very short intervals, and fuel oil was purchased at 6.5c per gallon.

Apparently, the unit was in perfect condition after its relief work was completed — just an additional proof that a Diesel engine "can take it" even when continuously overloaded and placed in the hands of inexperienced operators.

It is impossible to estimate the value of the work performed by this unit, but the consensus of opinion among officials of the American Air Filter Company is that the ten days' operation gained by its use before regular electric service was restored, considering good will as well as work turned out, was worth thousands of dollars. At any rate, it can be truthfully stated that the entire cost, including operating expense and cost of usage, was just a drop in the bucket compared to the value of the service rendered.

• • •

Editor's Note: In addition to the Caterpillar generating set which was so usefully put to work by the American Air Filter Co., two similar 60-kw. Caterpillar Diesel electric generating sets enabled Tube-Turns, Inc., to put hundreds of their employes back to work immediately that the plant was usable, and so successful were these emergency sets, both of them have been purchased as permanent installations by Tube-Turns, Inc.

A 20-kw. Caterpillar Diesel generating set went into service in the Standard Printing Co.'s plant in Louisville. The same thing applies to the C. G. Deering Ptg. Co., who were able to get a 40-kw. Diesel generating set. Another went into the Standard Gravure Corporation's plant. At Brown-Williamson's, where 250 flood sufferers were being housed, a Caterpillar Diesel set supplied electricity for lighting the building and so added to the comfort of the refugees. All in all, a great deal of credit is due the Caterpillar Traction Co. and to Roy C. Wahayne Co., their Louisville distributor, for doing their bit to relieve the tragic conditions which surrounded Louisville during the peak of the flood.

MAIERFORM

IT is interesting to note, in connection with the description of the first large Diesel collier. *Eildon,* referred to in the London Letter ol last month, that a repeat order has been placed by Messrs. George Gibson for a duplicate vessel. This order brings the total number of Maierform vessels built, converted and on order throughout the world to 323.

VORTEX SPARK ARRESTER SILENCERS
ENGINEERING SPECIALTIES CO., Inc.
39 CORTLANDT ST., NEW YORK CITY

CRACKED HEADS WELDED
• **EXHAUST VALVE SEATS HARD SURFACED**
Satisfaction Guaranteed
BRODIE AN ENGINEERING SERVICE
117 Clifton Pl. Brooklyn, New York

Now available with **DIESEL POWER**
ELCO CRUISERS
Write for information
PORT ELCO, 247 PARK AVE., N. Y. C.

The POWER to START!
Dependable air compressors are vitally important for starting Diesel engines.
Write today for details and prices on
QUINCY Compressors
QUINCY COMPRESSOR CO., QUINCY, ILL.
Branch Offices: 905 W. Wacker Drive, Chicago and 30 Church Street, New York

Specialized Training in-
One of the world's finest and largest Diesel training schools. Lessons prepared under supervision of R. G. Sloan, consulting engineer of broad experience. Day and night and Home Study Courses. Shop training. Employment Department for graduates. Schools at Philadelphia, Pittsburgh and Baltimore.
Write for literature.
JOURDEN
DIESEL SCHOOLS, Inc.
2831-2839 NORTH BROAD STREET
PHILADELPHIA, PA.

YOUNG
HEAT TRANSFER SURFACES FOR COOLING
GASOLINE OR DIESEL ENGINES ON TRUCKS • BUSSES • TRACTORS • RAIL CARS • LOCOMOTIVES • POWER UNITS
C. H. BULL, 115 10th St., San Francisco, Cal.
L. O. STRATTON, 811 15th St., Denver, Colo.
YOUNG RADIATOR COMPANY
RACINE, WISCONSIN

DIESEL PROGRESS

INDEX OF ADVERTISERS

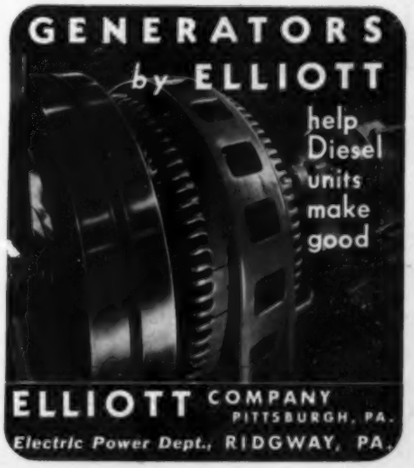
	PAGE
Aluminum Company of America	53
American Air Filter Company	9
American Bearing Corp.	16
Atlas Imperial Diesel Engine Company	18
Brodie System, Inc.	67
Buchi Syndicate, The	19
Buckeye Machine Company	66
Caterpillar Tractor Company	Third Cover
Cooper-Bessemer Corp.	Fourth Cover
Crocker-Wheeler Elec. Mfg. Co.	15
Cummins Engine Company	8
Cuno Engineering Corp.	65
Elco Works, The	67
Elliott Company	67
Engineering Specialties Co.	67
Erie Forge Co.	17
Fairbanks, Morse & Co.	61
Farrel-Birmingham Co.	67
Goulds Pumps, Inc.	67
Gulf Refining Company	Second Cover
Hemphill Diesel Schools	60
Illinois Testing Laboratories, Inc.	55
Jadson Motor Products Company	57
Johnson, Eads	67
Jourden Diesel Schools, Inc.	67
Korfund Co., The	12
Liquidometer Corp., The	61
Macmillan Petroleum Corp.	2-3
Maxim Silencer Co., The	58
National Forge & Ordnance Co.	66
National Refining Company	54
National Schools	20
National Supply Co.	56
New York Diesel Institution	66
Nordberg Mfg. Co.	1
Norma-Hoffmann Bearings Corp.	10
Nugent & Co., Wm. W.	6
Peet & Powers, Inc.	61
Petrometer Corp.	66
Pittsburgh Equitable Meter Co.	67
Power Manufacturing Co., The	66
Quincy Compressor Co.	67
Ross Heater & Mfg. Co., Inc.	59
Schoonmaker Corp., A. G.	65
Sinclair Refining Co.	11
SKF Industries, Inc.	4
Snow & Petrelli Mfg. Co.	60
Socony-Vacuum Oil Co.	7
Standard Oil Co. (Indiana)	51
Superior Diesels	56
Texas Co., The	52
Twin Disc Clutch Company	13
United American Bosch Corp.	62
Viking Pump Company	64
Vortox Mfg. Co.	68
Waukesha Motor Co.	14
Weatherhead Co., The	64
Weston Electrical Instrument Corp.	63
Worthington Pump & Machinery Corp.	5
Young Radiator Co.	67

FARREL
GEARS GEAR UNITS GEARFLEX COUPLINGS
for Marine and Industrial Service
FARREL BIRMINGHAM COMPANY, INC.

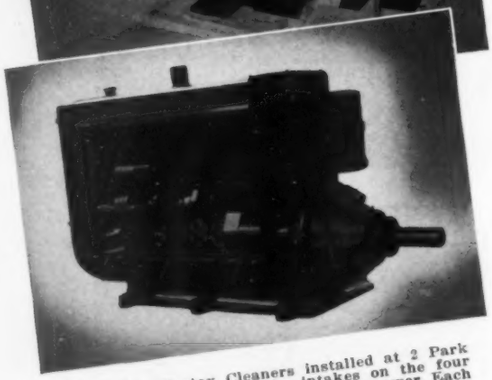
Pittsburgh Fuel Oil Meter
This meter which measures through true positive piston displacement will measure fuel oil accurately over any range of flow regardless of variation in inlet or flowing pressure.
PITTSBURGH EQUITABLE METER CO.
PITTSBURGH, PA.

EADS JOHNSON M.E. Inc.
Established 1910 - Tel. BArclay 7-9390 - Incorporated 1918
117 Liberty Street, New York City
Naval Architects • Marine Engineers • Shipbuilders
Designed and Built under our Supervision
TANKERS and CARGO SHIPS 5000 to 12500 TONS D.W.
FERRYBOATS..STEAM, DIESEL and DIESEL ELECTRIC
LIGHTERS....STEAM, DIESEL and DIESEL ELECTRIC
TUGBOATS.....STEAM, COAL and OIL BURNING
TUGBOATS.....DIESEL and DIESEL ELECTRIC
RIVER TOWBOATS.....STEAM, STERN WHEEL
RIVER TOWBOATS.DIESEL, SINGLE and TWIN SCREW
Barges for Oil, Deck Loads and Derricks
Floating Dry Docks of Wood and Steel Construction
Surveys - Valuations - Reports - 35 Years' Experience
Member, Society Naval Architects and Marine Engineers; Member Maritime Association of Port of New York; Licensed for Professional Engineering by New York State.

GOULDS HYDROIL
CENTRIFUGAL PURIFIERS
For fuel and lubricating oils
GOULDS PUMPS, Inc.
Seneca Falls, N. Y.

GENERATORS by ELLIOTT

help Diesel units make good
ELLIOTT COMPANY PITTSBURGH, PA.
Electric Power Dept., RIDGWAY, PA.

DOUBLE BARRELED *Efficiency*



● One of the four Vortox Cleaners installed at 2 Park Avenue to protect and silence the intakes on the four 450 hp. Worthington Diesels used to generate power. Each cleaner has a capacity of 2300 cu. ft./min.

Two Cooper-Bessemer Diesels (140 hp.) in the municipal plant at Cooper, Texas, each protected and silenced with Vortox Cleaners of 600 cu. ft./min. capacity.

Vortox Cleaner is standard installation on the Superior Diesel described in this issue. This semi-portable unit uses a cleaner with a capacity of 265 cu. ft./min.

Maximum efficiency

BECAUSE OF TRIPLE ACTION CLEANING

Vortox is the only cleaner combining the three fundamental cleaning principles of Centrifugal Action to throw out the heavier particles, Oil Scrubbing to remove the finer particles, and Filtering to give a final cleaning to the air before it passes into the combustion chamber of the engine.

PLUS

Efficient Intake Silencing

Quieter Operation is the *plus* feature —the extra dividend that you get in every Vortox Air Cleaner, and at no extra cost!

VORTOX Cleaners come in sizes to fit ALL types of installations from the smallest tractor engines to the largest power-plant Diesels . . . and in *every* model you get the double efficiency of *Cleaner Air* PLUS *Quieter Operation*. Be sure you get this complete performance by specifying VORTOX!

VORTOX MANUFACTURING COMPANY • CLAREMONT, CALIFORNIA

Vortox

OIL TYPE SELF-WASHING AIR CLEANERS

High Performance

—MINING WITH DIESELS AT 10,000 FEET

This D13000 engine drives a six-cylinder, two-stage compressor supplying air for drifters, stopers, jack hammer, drill sharpener, tugger hoists, and (occasionally) air lift, in the mine shafts.

These two D13000 engines supply power for concentrating mill—driving two ball mills, classifier, flotation machine, two thickeners, two jaw crushers, filter and accessories.

The Aztec Mine—in northern New Mexico—located at an altitude of 10,000 ft. Two shafts are worked 16 hours a day and ore mill runs continuously for 160 hours a week.

THAT Diesel power, as perfected by "Caterpillar," costs only one-half to one-fourth as much as other types of power, is being proved in thousands of installations — in every kind of industry. The three engines faithfully serving the isolated Aztec Mine in New Mexico offer one of many such instances — also proving their full dependability under difficult conditions of high elevation and unusual load demands.

Representing a total of 375 hp. and running from 16 to 24 hours a day, these three D13000 engines thus far have a record of 27,000 engine operating hours averaging *only 36c per hour for fuel, lubricating oil and all maintenance charges.* "Needless to say," writes M. W. Gorman, Superintendent, "such excellent performance has made us enthusiastic boosters for 'Caterpillar' Diesels."

Money saving and satisfaction with these efficient, modern power-plants are not confined to operating factors. . . . *Low prices* of "Caterpillar" Diesel Engines with their high standard of quality are made possible by large volume production. These engines are used in thousands of tractors and road machines, in the equipment built by 83 machinery manufacturers, and by hundreds of other power users. For further information, get in touch with our nearest dealer or direct with us.

SEVEN ENGINE SIZES—from 44 to 160 hp.

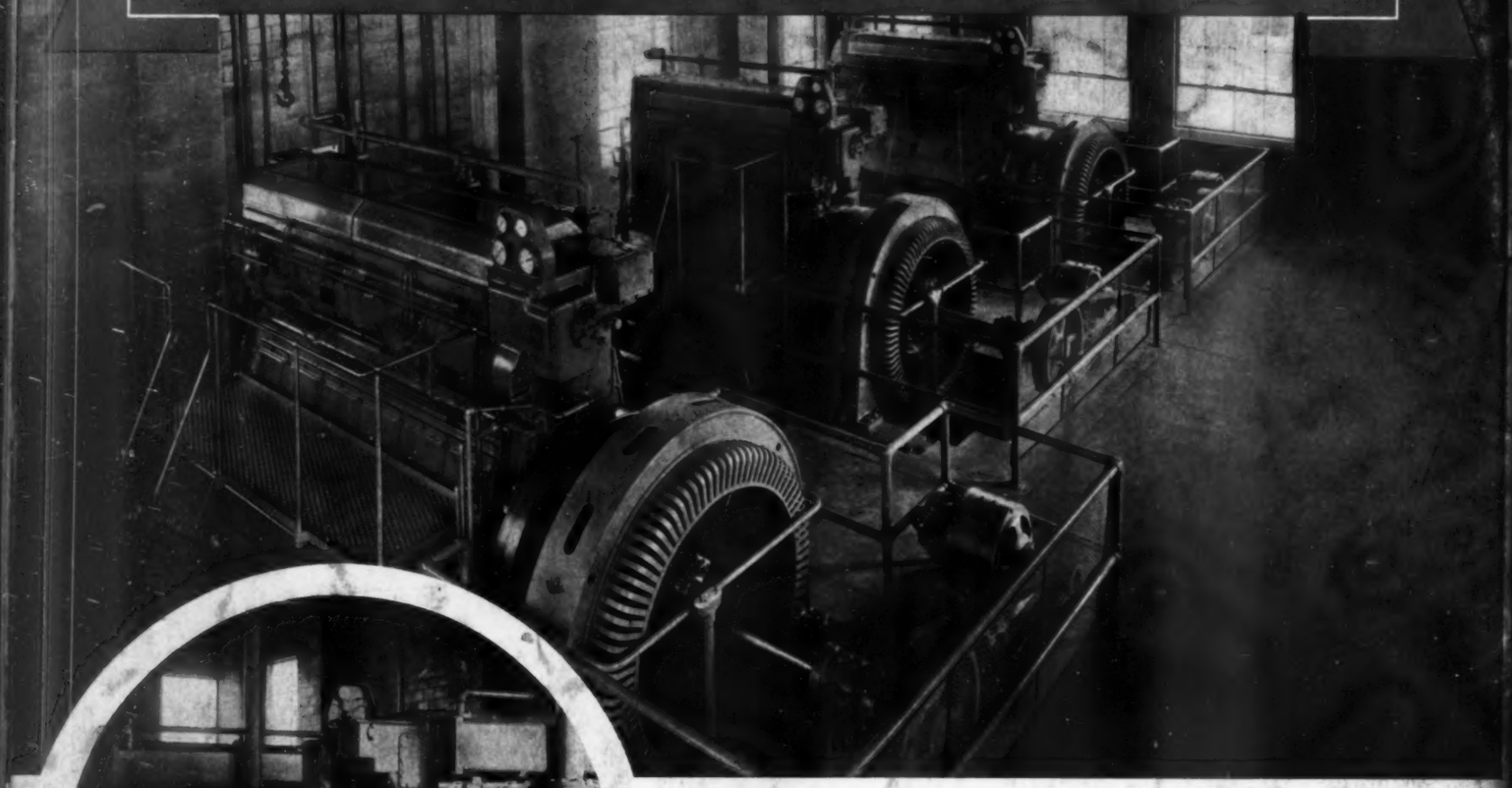
CATERPILLAR DIESEL ENGINES

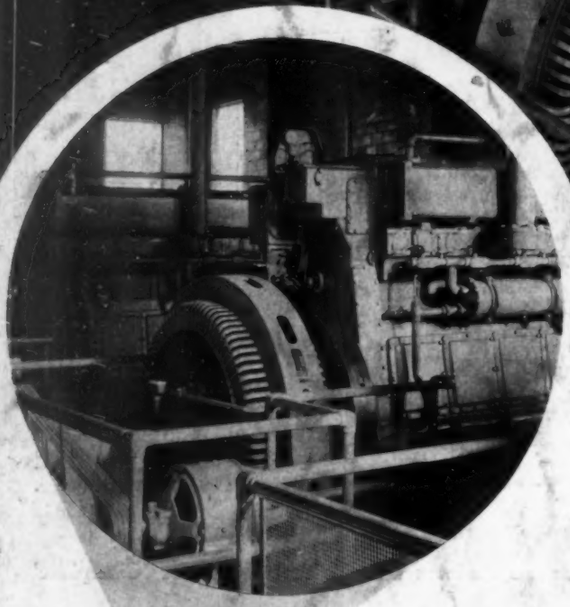
REG. U. S. PAT. OFF.

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS

WORLD'S LARGEST MANUFACTURER OF DIESEL ENGINES

Can You Photograph "ECONOMY"?





CITY OF OGDEN, IOWA — Water plant contains three Cooper-Bessemer Type GN Diesel-electric sets. A pair of "fours," each rated 185 H. P. at 400 r. p. m. And a "six," rated 250 H. P. at 400 r. p. m.

WE DID . . *Take a Look!*

Here is the world's cheapest way to pump water . . . modern Cooper-Bessemer Diesels, driving electric generators!

This is but *one* of the power services where the ECONOMY of Cooper-Bessemer Diesels is attracting nationwide attention. In *your* case, for instance, would you be satisfied with a power-cost reduction of 60 to 70%? We suggest that you call in the Cooper-Bessemer representative.

THE COOPER-BESSEMER CORPORATION

Mt. Vernon, Ohio — PLANTS — Grove City, Pennsylvania

25 West 43rd St. New York City — Mills Bldg. Washington, D. C. — Hoffar's Limited. Vancouver, B. C. — 53 Duncan St. Gloucester, Mass. — Esperson Bldg. Houston, Texas — 640 E. 61st St. Los Angeles, Calif. — The Pacific Marine Supply Co. Seattle, Washington